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PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, Esq., F.R.S.

VOL. III.
1865, NOVEMBER 15, TO 1867, JUNE 19.

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BRITISH METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, Esq., F.R.S., Secretary.

1865, NOVEMBER 15.

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C. BROOKE, Esq., F.R.S., President, in the Chair.

James Austin, Esq., 13 Moorgate Street, E.C.;
Rev. Alexander Beverley, A.M., Ashley Place, Cuparstone, Aberdeen;
Francis Edward Carey, Esq., M.D., M.R.C.S.E., Guernsey;
Joseph Gledhill, Esq., St. Paul's School, Halifax;
Capt. Oliver Halvane Stokes, R.E., Dingle, Kerry, Ireland;
Richard Strachan, Esq., 11 Offord Row, Barnsbury;
were balloted for and duly elected Members of the Society.

The name of One Candidate for admission into the Society was read.

CVII. *On extended Series of Meteorological Observations in Russia.* By Lieut. Rikatcheff, I.R.N. Translation from the Report of the Director of the Hydrographical Department of Russia.

In my last report it was stated that the Minister of the Navy proposed to the Hydrographical Department to sketch out a plan of daily telegraphic communications from all our seas, for the purpose of foretelling the earliest approach of storms. Having carefully considered this question with Kupffer, Director of the Central Physical Observatory, the department came to the conclusion that, for the complete investigation of storms and for the best system of foretelling the most probable state of atmospheric currents, it would be necessary to take the following measures:—

1st. To increase the observing strength of the Meteorological Observatories at Revel, Nikolaëv, Arkhangel, Astrakhane and Nikolaëvsk, and to make these points the principal meteorological stations for the adjacent seas. For this purpose it would be necessary that all those stations be furnished with full sets of meteorological instruments.

2ndly. In addition to the meteorological stations which are already established at Cronstadt, Kame, Bakoo, Astrabade, and Petersburgh, to found others at Narva, Baltic-port, Gapsal, Pornov, Riga, Libau, Wiborg, Abo, Uleaborg, Torneo, Odessa, Sevastopol, Kerch, Berdiansk, Taganrock, Pogti, and Kola*.

3rdly. As for the most part naval officers are not resident at these places, it will be necessary to engage observers with salaries.

4thly. To provide all stations with new instruments, carefully examined before use at the Central Physical Observatory. At present, secondary stations it is intended to furnish with barometers and thermometers only. The observations to be taken three times every day, viz. at 7 A.M., 2 P.M., and 9 P.M.

At 8 A.M. every day to send by telegraph the observations taken at those times to the Central Physical Observatory, where, from all the observations received, the most probable state of the weather for the following day will be deduced. This deduction will then be sent by telegraph to all sea-ports.

5thly. When the stations shall be finally settled, and the meteorological correspondence by telegraph in operation, it is intended to print a daily paper with meteorological intelligence, accompanied by a meteorological chart, and to send this paper by post to every sea-port, as well as to correspondents and other persons who are interested in meteorology.

This network of stations would be incomplete if it were confined to sea stations only. It is therefore imperatively necessary to include in this purpose many stations in the interior of Russia. The Ministry of Public Education, recognizing the importance of the practical application of meteorology to navigation, to trade, and to agriculture, has arranged to establish thirty meteorological stations at the following places*: Novgorod, Pskov, Vitebsk, Moghilev, Tchernigove, Zytomir, Kamenietz-Podolsk, Kishiniov, Riasane, Orël, Koursk, Krementchoog, Bakhmoote, Tzaritzin, Piatigorsk, Stavropole, Saratove, Samara, Simbirsk, Penza, Tambove, Ouffa, Perm, Viatka, Nijni-Novgorod, Yarosflavle, Tver, Vologda, and at Whytegra.

---

* Besides these stations, it is intended to establish meteorological stations in the Eastern Province of Siberia at the following points:—Petropavlovsk, Dooë, De-kastry, Imperial Harbour, and in harbours Olga, Nahodka, Vladivostok, and Novgorodskaia.

This plan of practical application of meteorology, having been submitted to the Academy of Sciences, was approved and warmly supported.

On the 10th of August, 1864, the plan was favoured with the approbation of His Majesty the Emperor, and the necessary sums of money for instruments, printing, and salaries were ordered.

When the budget of 1865 was confirmed, the Ministry of the Navy, as well as the Ministry of Public Education, ordered the necessary instruments; meanwhile Kupffer entered into correspondence with different persons for the purpose of engaging observers.

All the instruments will be ready by the spring of the year 1865; and it is expected that by the same time the observers will be engaged, and that by the autumn of the year 1865 the regular telegraphic correspondence of the meteorological observatories will be at work.

To render the system of telegraphic correspondence of meteorological observations more complete, and taking into consideration that all great storms come to us from the west, Kupffer considered it necessary to receive by telegraph the observations made at several stations in western Europe. With this view he was sent in December 1864 to France, Prussia, Italy, Austria, and Holland, to consult scientific men about the choice of the best points of observations, and to arrange a gratuitous transmission by telegraph of these observations.

---

* Besides the Magnetical and Meteorological Observatories which are now in action at Ekaterinburg, Barnaool, Nerchinsk, Helsingfors, Moskva, Sytha and Pekin, and meteorological stations established at Alexeevskaia, Aralsk, Ardatove, Balahine, Warsaw, Volmansk, Grigoretsk, Gorbatove, Glasove, Derpt, Zlatooust, Tahime, Konstantinovskaia, Kalooga, Kamenskaia, Kiëve, Kozmodemiansk, Kostroma, Kochetova, Lencorane, Loogane, Mitawa, Morshpansk, Nijni-Tahilsk, Novopetrovskaia fortress, Tcherkask, Tobolsk, Tomsk, Oostimedveditsk, Oorupinskaia, Ooralskaia fortress, and in forts Alexvandrovskoi, Petrovskoi, and fort No, 1.

The proposed plan was well received by all the scientific meteorologists, by Dove at Berlin, by Le Verrier at Paris, by Matteucci at Turin, by Jelinsky at Vienna, and by Buys-Ballot at Utrecht, as well as by several telegraphic companies, which for the most part promised to send the meteorological dispatches to Russia gratuitously.

To make this system of daily telegraphic communication of meteorological observations more extensively useful, it was considered necessary to combine those observations with others made at sea, to prepare charts of the currents of the seas, and of the direction and strength of wind by the combination of land and sea observations. To follow and somewhat extend the instruction given by the Royal Society of London to the Board of Trade in 1855, it was thought desirable to collect, arrange, and discuss the meteorological observations which have already been made.

For the study of meteorological phenomena from different places, it is most important to have a knowledge of the laws of meteorological changes in those places; without this knowledge it is not possible to determine the future changes in the state of the atmosphere, which most probably would follow certain principal currents of air.

For this purpose the Hydrographical Department resolved to prepare charts of winds from the observations which have been made on our seas, and to begin this work at once, by collecting all observations, from ships of all kinds, made in the Baltic sea, and near to it, for many years past. This work is entrusted to Captain Treskovskoy, I.R.N., attached to the Hydrographical Department, who has divided the Baltic sea into spaces of 1° in latitude and 2° in longitude, and the adjacent gulfs into spaces of ½° in latitude and 1° in longitude.

He has begun this work with the assistance of two officers, first extracting from the log-books of all ships, both merchantmen and others, the meteorological observations which have been made since the year 1844.

This work will take a long time; and as the department at present is not able to devote more than two assistants to aid Captain Treskovskoy, some considerable time must elapse before a good chart of the winds can be prepared even for the Gulf of Finland. Captain Treskovskoy proposes to prepare in the first instance a chart of winds of the Gulf of Finland from a comparatively small number of observations, which he expects to have ready by the end of the year 1865. This chart will require considerable additions, but will give an approximation to the principal winds of this gulf, and will probably indicate the direction in which he must make improvements in the plan of his work in obtaining the same information for the other seas.

CVIII. *On the First Publication of the Results of the extended series of Meteorological Observations in Russia.* By Lieut. Rikatcheff, I.R.N.

Our readers are acquainted with the contemporary advancement of meteorology in western Europe, as well as with its successful application in England and France to the foretelling of the most probable approach of storms and other sudden changes of weather for the use of sailors and agriculturists. In *our* country it is to the Ministers of the Navy and of Public Instruction that we are indebted for the introduction of this system of meteorology, based on the same principles which are adopted in England and France.

The Ministry of the Navy, in order to adopt on the coasts of our seas the well-known system of the English Rear-Admiral Fitz-Roy, had established seventeen new meteorological stations in our principal ports, and has proposed to the Ministry of Public Instruction to establish similar stations over the whole area of the interior of Russia.

The Minister of Public Instruction, after careful consideration, laid before the Consul of the Empire a proposal, to carry out which it was necessary to establish thirty meteorological stations. In consequence of this the Consul of the Empire, with the approbation of His Majesty, ordered—

1st. That the observations are to be entrusted to persons recommended by the authorities of public instruction.

2ndly. The necessary funds for establishing these meteorological stations in the interior of the empire.

According to this order of His Majesty, it was proposed to the Director of the Central Physical Observatory to choose the telegraphic lines, the places for the meteorological stations, and to found the simplest and least troublesome methods of telegraphic meteorological communication.

In consequence of this proposal, Kupffer formed a list of thirty-nine new stations, which he believed it was necessary to establish, besides the sea stations, and four stations in Moscow (Moskva)—Dorpat, Derpt, Warsaw, and Kieve—which by the order of His Majesty communicate gratuitously by telegraph their meteorological observations. Kupffer found it necessary, for the adjustment of instruments in the meteorological stations and for the instruction of observers, to detach two persons, viz. Captain Treskovskoy and Mr. Miller—the first to visit the eastern part, and the second the western part of the empire.

After this plan was received by the Minister of Public Instruction, he applied to the Minister of Posts and Telegraphs on the institution of the daily telegraphic communication of meteorological observations at thirty-nine meteorological stations proposed by Kupffer; and steps were taken to prepare the instruments for these stations. When the instruments were ready, Messrs. Treskovskoy and Miller were detached for their adjustment in July 1865—the first, by the order and at the expense of the Ministry of the Navy, to the eastern part, and the second, at the expense of the Ministry of Public Instruction, to the western part of Russia. Meanwhile the Minister of the Interior took into consideration that the proposed system of meteorological stations should not only be made useful to sailors and agriculturists, but, if possible, be made valuable to science.

The laws of atmospheric phenomena are determined and explained exclusively in regard to the property and general causes of phenomena; but the order in which they follow one after the other, and the causes of their changes in different localities, have been but little investigated. For example, we know that the direction and the force of winds is in general explained by the continual atmospheric currents, from the equator to the poles, and from the poles to the equator, by the diurnal motion of our globe, by various conditions of the atmosphere over the seas and the continents, by the line of coasts of those seas, by chains of mountains, and by the form of the earth's surface. We know a decrease of temperature condenses vapour, and that this condensation of vapour sometimes produces showers, which are often followed by electrical phenomena, and that in consequence of these showers a comparative vacuity is produced, and the surrounding air rushes towards these points.

But we are not so well acquainted with the reasons why such a phenomenon occurs in this place and not in another—why it should occur at this time and not at another—why at this time at other places other phenomena are observed—in what relations those phenomena are to each other—why they take place one after another in a given order, and not in any other order—and so on. For example, Why at a given time is the wind north in Tver, west in Kostroma, and east in Toola? Why in Moscow and in Riasane is it cloudy when it rains at Smolensk? Why will the wind be north to-morrow where it is at the present time east? and why will it be fine weather to-morrow in some places where it is gloomy this day? Why do the barometer and thermometer rise or fall in Novgorod, and remain invariable at Yaroslavle? Meteorology at present cannot answer these questions.

Probably science will never be able to answer *all* these questions. But it is most probable that science will in time be able to answer a great number of them, and some with precision. The laws of nature are unchangeable. If, on one hand, a law gives an explanation of a phenomenon, on the other hand the phenomenon points out the law. The problem of the human mind in the sphere of physical sciences is to notice this connexion between the phenomenon and the law, and by means of comparative observations and deductions to deduce from the consequences their causes.

It is evident that for success in such investigations it is very important to make many observations, to have a system of reduction of the observations, and to have a ready means of comparing results. The graphical method is very useful for this purpose, as giving the possibility of examining at a glance the observations taken in different localities and of various kinds—as, for example, the synoptic charts of several storms which were published by Admiral FitzRoy: those charts are included in the volume of FitzRoy's 'Weather Book, a Manual of Practical Meteorology;' this book is translated into the Russian language by Captain Treskovskoy. An examination of such a chart can give some ideas which the simple comparison of several numbers could not give. [The first of a series of these charts was exhibited at the Meeting.]

The governors of all European provinces of Russia are requested to give assistance for the institution of regular Meteorological Observations in the capital of each province, and to publish the results in the provincial papers.

CIX. *Temperature at Greenwich and at Newport.*

By John C. Bloxam, Esq., M.R.C.S.

A comparative meteorological statement for two different localities is clearly an interesting and important branch of meteorological inquiry. A correlative history of any one meteorological particular for two spots far apart would always be very instructive. Greenwich and Newport are not *far* apart, indeed; but the distance suffices to put them under different conditions, and a comparison of temperature for these two sites may be not devoid of interest. Mr. Glaisher's Tables of temperature, published in the 17th Number of the 'Proceedings,' with similar Tables in 'Meteorology of Newport,' afford materials for such a comparison. The Tables for Newport are based on sixteen years of observation, including 1841–56. The Tables for Greenwich are for the fifty years 1814–63. A period of sixteen years is sufficient to give normal average daily values, if the results of observation be appropriately treated; fifty years do not suffice for this without such treatment. Mr. Glaisher's combination of fifty years gives daily means of irregular abnormal values. Fifty years suffice for the discovery of secular changes; and Mr. Glaisher considers that a progressive change is shown to have taken place in atmospheric temperature during the fifty years. Such change of course impairs the comparability of the two records to a certain extent, but not perhaps in any material degree; some allowance may be made for this change, but it would be difficult to make any numerical correction for it in the calculations. The normal temperature proper to each day must be determined by evidence obtained somehow from the recorded temperatures of several adjacent days; the symmetrical bearing of a group must be taken as the correct indication of the true value belonging to the whole. The normal temperature for each day in the year had been determined for Newport by a meaning process which gave a daily progression as free from jumps and irregularities as the true average line might be expected to be. A line such as this, besides conforming to nature's progress, has the great advantage of admitting of division and grouping at pleasure without danger of falsifying the daily progress. Two independent records treated in this way admit of easy comparison; but when it was attempted to compare Mr. Glaisher's adopted means with those for Newport, it was found impossible to do this satisfactorily, because, whilst the daily values progressed smoothly and regularly in one line, they proceeded by jumps and with vacillation in the other. Whether the line for Newport would have corresponded with that for Greenwich if it had been reduced by the method that has now been used for Greenwich, I cannot say, and I am not sufficiently acquainted with this method to give it a fair trial; but it does not seem likely that any two lines treated in the same way, independently, would show corresponding irregularities such as these for Greenwich. I reduced Mr. Glaisher's Table of Mean Temperature (p. 342) by the same method I had previously used for Newport, and I obtained a line very similar to, and easily compared with, that for Newport. It appears to me that the method used by Mr. Glaisher is not sufficiently effective for its purpose: I do not see the utility of transforming the *actual* means into such vacillating "adopted" means. The annexed Table shows the difference in the results obtained by the two methods. The first column for each month in this Table shows the daily progression given by Mr. Glaisher's Table of adopted means; the second column shows the progression as obtained by the other method. The method I have used will be readily understood from a glance at the following Table, which consists of the calculations used for obtaining the normal or adopted means for July 14 and 15. The numbers in Mr. Glaisher's Table for mean temperature are the raw materials for these calculations, and these are introduced in the first column. The first value in the second column is the mean of the first ten values, viz. July 5–14, in the first column; the second value in the second column is the mean for July 6–15, and so on. The values in the third column are, in the same way,

July 5	62°·8		
6	62·5		
7	61·4		
8	60·8		
9	61·0		
10	61·6	61°·96	
11	62·1	61·97	
12	62·6	61·90	
13	62·3	62·02	
14	62·5	62·15	62°·032
15	62·9	62·18	62·017
16	61·8	62·18	
17	62·6	62·09	
18	62·1	61·98	
19	61·3	61·89	
20	61·6	61·81	
21	61·2		
22	61·5		
23	61·4		
24	61·7		

the means of successive decades in the second column. The effect of this process is simply and with *accuracy* to take from the high values in proportion to their excess and give what is taken away to the low values, within a definite distance, in proportion to their defect. The difference in the results of the two methods is somewhat important in one place. The method used by Mr. Glaisher makes the temperature for July 14 and 15 to be 62°·5, this being the maximum value for the year; and it makes the temperature for August 3, one of the hottest days of "the hottest period," to be 62°·4. The method I have had recourse to gives 62°·08 and 62°·02 as the temperatures for July 14 and 15, and 62°·22 as the temperature for August 3. Now if 62°·5 were the mean of the fifty values for July 15, nothing could be said against it on the score of its correctness; but 62°·5 professes to be the nearest approximation to the *true* temperature belonging to July 15; and this it appears to me it is not. It must be admitted that the true temperature belonging to any day is to be deduced from the observed temperatures of a few days preceding and of a few days succeeding the day in question, together with that of the day itself. If this be so, a range of four days each way from *the* day cannot be too much to allow; and then the nine days give 62°·28 as the temperature for July 14, and 62°·24 for July 15, and these two nine-day mean values are each below Mr. Glaisher's adopted temperature for August 3. If only three days instead of four be allowed, we shall then get the same temperature for July 14 and for July 15 as that assigned to August 3 in Mr. Glaisher's Table. The Mean Temperature Table at p. 342 gives 62°·9 as the temperature of July 15, and 61°·8 as the temperature of July 16; the mean of these two is 62°·35; and this being so, can 62°·5 be the nearest approximation to the true temperature belonging to July 15? It seems quite evident that the method used for obtaining these adopted values does not sufficiently diffuse the weight of abnormal values accidentally high or low. The 15th of July happens, on the average of fifty years, to have had a temperature 1°·1 higher than the 16th. The high temperature of the 15th belongs almost as much to the 16th as to the 15th; and seeing that the 19th has a temperature 1°·6 below that of the 15th, a considerable share of that which has fallen, in fact, upon the 15th must *belong* to the 19th. Mr. Glaisher by his method reduces the original mean value for the 15th by 0°·4, and raises that for the 19th by 0°·3; the method I have used reduces the one by 0°·9, and raises the other by 0°·6: and the result of this is, that whilst Mr. Glaisher leaves the 19th so much as 0°·9 below the 15th, when "the hottest period" is approaching, I leave it only 0°·14 below. In the Table of normal temperatures I have calculated, no portion of the high value falling to July 15 can be transferred to a greater distance than nine days. The excess falling to any one day may be distributed amongst nineteen days (nine before and nine after); but the incidence upon any one of the nineteen days depends partly upon the distance of that day from the day of excess (the values that are more than five days distant being less affected by the excess than those that are *not* more than five days distant*), and partly upon its own defect, because the greater the defect the more does it take of the excess. By this distribution of excessive and defective quantities, the two hottest days in the year are brought within the hottest period of the year.

The normal values for temperature for each day as I have calculated them are given in Table II. I shall quote from this Table as the standard for Greenwich. The statistics for Newport are taken from the 'Meteorology of Newport in the Isle of Wight;' the facts may be found in the Tables, or may be easily deduced from them, or they may be found indicated in the diagrams; the daily values for wind and for cloud have been given in the form of diagrams. Reference will occasionally be made to maximum and minimum values for atmospheric pressure, which are taken from a Table on page 141, No. 3 of 'Proceedings;' when other intermediate values for atmospheric pressure are referred to, they will be taken from the full Table of daily values from which the extremes are taken.

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* I do not know whether this unequal but symmetrical incidence will be pronounced to be a defect; but if it be considered that the more distant days ought to have as large a share of the *spare* weight as the nearer days, it then follows that the 21st of June and the 21st of December ought to have the same influence in determining the temperature belonging to March 21 as any other day, and then the mean temperature of the year will be made to be the true temperature for each day in the year. It is impossible to specify *how* far the smoothing process should reach, but it ought not to be carried so far as to obliterate the natural or normal inclines: it is not easy to do this whilst, 1st, the extremes of the group embraced have an influence in inverse proportion to their distance from the centre, or date concerned, and, 2ndly, the change made in any value is in direct proportion to its departure from the medium line. The oftener the process is repeated the greater is the meaning range; but the greater the range the less is the influence of the distant dates. With fifty-year means, it is sufficient to go through the process twice; but with sixteen years it was found necessary to go through it four times. In each case but little change would be made by going further.

The *mean* temperature for the year at Greenwich is 0°·29 lower than it is at Newport—the former being 49°·09 *, the latter 49°·38. The *minimum* at Greenwich is 36°·10; the *minimum* at Newport is 38°·66. The *maximum* at Greenwich is 62°·22; the *maximum* at Newport is 61°·37. The *mean* occurs on April 29, and on October 20 at Greenwich; on May 5, and October 20 at Newport. The *minimum* falls on January 9 and 10 at Greenwich; on February 11 at Newport. The *maximum* falls on August 2 and 3 at Greenwich; on August 3 and 4 at Newport. The 30 days of lowest temperature at Greenwich are December 26 to January 24, the mean value for these days being 36°·82; the 30 days of lowest temperature at Newport are January 25 to February 23, the mean value for these days being 39°·30; so that during one month Greenwich has a lower average temperature by 2°·48 than Newport has for any 30 days. The 30 days of highest temperature at Greenwich are July 12 to August 10, the mean value being 62°·01; the 30 days of highest temperature at Newport are July 21 to August 19, the mean value being 61°·05; so that during one month Greenwich has a higher average temperature by 0°·96 than Newport has for any 30 days. At Greenwich there are 190 days below the *mean*, and 175 above; at Newport there are 195 below, and 170 above. There are 205 days of rising temperature at Greenwich, counting from *minimum* to *maximum*, and 160 of falling temperature, counting from *maximum* to *minimum*; at Newport there are 173 days of rising, and 192 of falling.

The *mean* occurs, in the spring, six days earlier at Greenwich than at Newport; in the autumn it occurs on the same day at each place. The increment of temperature is peculiarly rapid at Greenwich at the spring period. On April 29 the increment for the day is 0°·33 at Greenwich, the *maximum* rate for the year, whilst at Newport it is on this day 0°·14. The rate is higher at Greenwich than at Newport during April 13 to May 5; if the rate during this period had been the same at Greenwich as it is at Newport, the temperature would be only 48°·54 on May 5, this being 0°·55 below the Greenwich *mean*. The *mean* temperature of Greenwich is experienced at Newport on May 3; the Newport *mean* is experienced at Greenwich on April 30. The *minimum* occurs at Greenwich a month earlier than it does at Newport; but

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* Mr. Glaisher gives this mean as 49°·03; the difference probably arises from his having divided the sum of the twelve monthly means by 12, whilst I have divided the sum of the 365 daily means by 365, this being the way in which I have always computed the annual means.

Newport temperature alters only to the extent of 0°·54 during the month—that is to say, during January 11 to February 11. The temperature is 0°·87 higher at Newport than at Greenwich, on the average, during the month of lowest Newport temperature, viz. January 25 to February 23.

Mean Temperature of each Month.

Month.	Greenwich.	Newport.	Difference.
	°	°	°
January	36·98	39·54	+2·56
February	38·68	39·33	+0·65
March	41·65	41·91	+0·26
April	46·34	46·80	+0·46
May	52·90	52·04	−0·86
June	59·02	57·62	−1·40
July	61·84	60·49	−1·35
August	61·17	60·72	−0·45
September	56·62	57·29	+0·67
October	50·20	50·61	+0·41
November	43·20	44·43	+1·23
December	39·74	41·04	+1·30

The "difference" for January in this Table is much greater than for any other month. The difference for the 30 days December 29 to January 27 is 2°·62, and the value for the 10 days of greatest difference, viz. January 7–16, is 3°·03, and that for the day of greatest difference, viz. January 10, is 3°·12. The *minimum* falls on January 10 at Greenwich; and hence the difference is the greatest on this day. June and July are shown to have the greatest difference in the summer, but the 30 days of greatest difference in this respect are June 20 to July 19, and the value for these days is 1°·60; the value for the 10 days of greatest difference, viz. June 21–30, is 1°·65, and that for the day of greatest difference, viz. June 27–28, is 1°·72. Temperature increases 1°·09 after June 27 at Greenwich, and 1°·96 at Newport, the *maximum* being attained on the same day at each place. The greater increment here noted for Newport probably depends upon the increasing temperature of the sea in the channel, which may be considerable for some time after the sun has attained his greatest altitude.

On April 26, Greenwich temperature rises above Newport temperature; on August 28 Greenwich falls below that of Newport. The latter movement occurs only 25 days after *maximum* temperature, whilst the former is 99 days before it. The *rise* (from April 26 to August 3) amounts to 14°·02 at Greenwich, and to 13°·24 at Newport; the *fall* (from August 3–28) amounts to 2°·36 at Greenwich, and 1°·36 at Newport. The warmth of the sea *keeps* temperature up at Newport more than it does at Greenwich.

Minimum temperature occurs on January 10 at Greenwich, and on February 11 at Newport. This discrepancy seems to depend upon the high temperature at Newport on January 10, rather than on the low temperature on February 11. A *local* minimum occurs at Newport on January 4 and 5, and this minimum is 3°·06 higher than the Greenwich *minimum* on the 9th and 10th. A *local* minimum occurs at Greenwich on February 13, and this minimum is 0°·26 lower than Newport *minimum*. Greenwich *minimum* is 2°·3 below its February minimum. Greenwich *minimum* is 12°·99 below Greenwich *mean*. Newport *minimum* is 10°·72 below Newport *mean*.

After the January minimum the temperature rises at Newport at the mean rate of ·04 daily to a *local* maximum on January 25; at Greenwich, the temperature rises from Greenwich *minimum* (January 10) at the rate of ·11 daily till January 25, and then at the rate of ·05 to a *local* maximum on February 7. A very reduced increment is therefore observable at Greenwich corresponding with a decrement which proceeds to the *minimum* at Newport. The primary depression having been great at Greenwich, the subsequent rise is comparatively rapid; the fall then succeeding is not very conspicuous, though a positive fall does occur at Greenwich between February 7 and 13. The alternations are in fact very similar at the two stations. The downward movement continues at Newport to January 5, and at Greenwich to January 9; increment then proceeds to a maximum on January 25 at Newport, and a simulated maximum is observable at Greenwich on the same day, and an actual maximum occurs on February 7. Decrement then recurs, and continues until February 12 at Newport, and until February 13 at Greenwich. The mean for the two minima at Greenwich is 37°·25; at Newport it is 38°·91. The intervening maximum is 1°·25 above the mean of the minima at Greenwich; at Newport this is 1°·10. The *minimum* is 2°·56 lower at Greenwich than it is at Newport. The *local* maximum is 1°·51 lower at Greenwich than at Newport. The mean temperature of January is 2°·56 lower at Greenwich than at Newport; the mean for February is only 0°·65 lower at Greenwich than at Newport. The near proximity of the sea at Newport will account for temperature being higher there in winter and lower in summer; but the explanation of these details will be found in the varying direction of the wind, and the influence of this upon the two places respectively.

Successive periods will now be compared so as to show the correlative effects of the varying conditions upon temperature as they occur in the course of the year. Temperature appears to be much more governed by the amount of cloud at Greenwich than it is at Newport, clear sky favouring the progress of temperature, whether this be rising or falling. The daily changes in temperature will be used as the basis of comparison. The following Table gives the daily progression, at each site, during the period January 1–27.

Date.	Greenwich.	Newport.	Date.
	−·14	−·02	January 1.
	−·16	−·02	
	−·14	·00	
	−·11	−·01	
	−·12	·00	January 5.
	−·11	+·01	
	−·10	·00	
	−·08	·01	
	−·05	·02	
January 10...	·00	·02	
	+·03	·03	
	·06	·03	
	·07	·05	
	·06	·06	
	·10	·06	
	·11	·07	
	·15	·08	
	·16	·08	January 18.
	·15	·07	
	·15	·07	
	·16	·07	
	·17	·05	
	·14	·04	
	·14	·02	
	·11	·01	
	·08	−·02	
	·06	−·04	January 27.

The S.W. wind gains the ascendancy on January 5, attains a high maximum value on the 19th, and on the 28th yields superiority to the N.W. The amount of cloud in the sky increases after December 28 to the *maximum* for the year on January 19; and the S.W. wind has a higher value on January 19, 20, 21 than on any other day between October 7 and June 4. Between January 18 and 22, the increment-rate is greatest, at Greenwich and Newport, in this period; and on the 25th the temperature attains a maximum at Newport. Vapour increases with temperature and

S.W. wind, the proportion of vapour in the atmosphere increasing from 1 in 145 on January 5 to 1 in 144 on January 19. The change of wind to S.W. (as observed at Newport) is attended by the same movement in temperature at each place; but the effect appears greater at Greenwich than at Newport. This may be explained by the much greater reduction of temperature at Greenwich than at Newport previously, from conditions that will be referred to subsequently; the temperature is 2°·15 lower at Greenwich than at Newport on January 25, notwithstanding the rapid rise at Greenwich.

After January 28th the N.E. wind rises daily in value until February 9, when it has the preponderance, and it keeps it for three days, having exceeded its own *mean* value on February 1, and risen above S.W. on the 8th, and above N.W. on the 9th.

Greenwich.	Newport.	Date.
+·07	−·04	
·05	·06	January 28.
·05	·07	
·05	·09	
·03	·10	
·03	·11	
·03	·12	
·05	·12	
·06	·12	
·06	·11	
·05	·11	
·04	·09	
·00	·08	
−·02	·06	
−·02	·03	
−·02	·02	February 11.
−·03	+·01	
−·01	+·04	
+·02	+·07	

Cloud diminishes during January 20 to February 15, the sun apparently acquiring sufficient influence to disperse the clouds before the date of N.E. preponderance. Temperature falls to the *minimum* at Newport on February 11, and to a *local* minimum at Greenwich on the 18th—this minimum at Greenwich being 0°·26 lower than the corresponding *minimum* at Newport. At Newport the N.E. lowers temperature on February 11 below the point it reached on January 4; but at Greenwich increment is maintained, though at a reduced pace, almost throughout this period, and on February 18 the temperature at this place is 2°·8 higher than on January 9. The diminution of cloud is considerable at this period of the year. The *maximum* degree of cloudiness being called 100, and the *minimum* 0, the amount of cloud for February 11 is 65; so that it falls 35 in a scale of 100 between January 19 and February 11, being on the 11th of February 22 lower than on January 4. Decrement of temperature now accompanies diminution of cloud. A thermometer enclosed in a box and so placed as to have the full benefit of the sun's rays, whilst it was well protected from the wind and radiation, gave its lowest reading, on the average, on January 11 at Newport.

On February 13, S.W. wind predonderates, the N.E. appearing again on the 27th. Cloud increases during February 16–24. The change of wind to S.W. is accompanied by a change of rate, the temperature increasing at Newport on February 12, and at Greenwich on February 14. The increment is considerably more rapid at Newport than at Greenwich. The S.W. at Newport has much more influence in raising temperature than the increasing cloud has in lowering it. The N.E. perhaps keeps to a higher value at Greenwich at this time than it does at Newport. N.E. keeps above its *mean* value at Newport during February 1–March 29, and N.W. does so during January 22–March 2; whilst S.W. is below its *mean* during January 29–March 31, and, with the exception of the first four days of April, to May 15: this strong tendency to northerly winds is probably more effective at Greenwich than on the southern coast. The increment-rate, it will be seen, diminishes at Newport on the 21st, and at Greenwich on the 23rd. N.W. increases in value on the 21st, S.W. diminishes on the 22nd, and N.E. increases on the 23rd, cloud coming to a maximum on the 24th.

Greenwich.	Newport.	Date.
−·01	+·04	February 13.
+·02	·07	
·02	·09	
·04	·11	February 16.
·06	·13	
·09	·14	
·12	·15	
·12	·16	
·15	·15	
·15	·14	
·14	·13	
·11	·12	February 24.
·11	·09	

A great diminution of cloud now ensues: the values for cloud decline almost daily during February 25–April 1, crossing the *mean* line on March 5, and falling 55 in the scale of 100 during the period.

Greenwich.	Newport.	Date.
+·11	+·09	February 25.
·10	·08	
.10	·06	N.E.
·10	·04	
·08	·04	
·08	·03	
·06	·02	March 3.
·05	·04	
·07	·03	
·09	·05	
·11	·07	
·12	·07	
·12	·10	
·14	·10	
·16	·11	
·17	·12	
·18	·13	
·16	·13	
·15	·13	
·12	·13	
·10	·12	
·10	·13	
·11	·13	
·11	·15	
·09	·15	
·10	·16	
·11	·18	
·13	·20	
·15	·21	March 25.
·19	·23	S.W.
·23	·24	
·23	·25	
·23	·24	
·23	·26	
·21	·24	
·21	·23	April 1.

This is a period in which the N.E. wind plays a very prominent part; its values begin to rise on February 23; it gains the preponderance on the 27th, and keeps it until March 25, falling to a minimum, which is a little below the *mean*, on April 1. After the middle of March, *either* N.E. wind or S.W. wind prevails for a considerable portion of the year, in which, if one of these is the first in the scale the other is the second; this is almost invariably the case until June 8. The rate at first varies in strict correspondence with the change of wind; the increment-rate lessens as the values for N.E. increase, and subsides almost to 0 soon after the N.E. preponderates—that is to say, on March 3 and 4. After this, the effect of diminishing cloud in raising temperature is very manifest; the increment-rate increases as long as cloud diminishes, and attains so high a value as 0·26 at Newport, this being only ·02 below the *maximum*. During the prevalence of the N.E., temperature rises 2°·91 at Greenwich, and 2°·62 at Newport. During the period of diminishing cloud, temperature rises 4°·80 at Greenwich, and 4°·70 at Newport. The rate for the former period is 0·10, and for the latter period it is 0·13, without distinction of site. The rate does not progress in precisely parallel lines at the two sites all through this period; and perhaps the same might be said in regard to wind and cloud. The progress is much the same on the whole, as regards temperature; but the clearer sky seems to tell more quickly upon temperature at Greenwich than at Newport. The influence of a clear sky in raising temperature now quite overpowers that of a N.E. wind in lowering it. In the middle of March temperature stands at the same level at the two places, 0°·03 being the greatest difference during March 14–17. N.E. is at a high maximum during March 4–11; and in this period the increment-rate at Greenwich far exceeds that at Newport. On March 26, S.W. prevails; and just before this date the increment-rate is much higher at Newport than it is at Greenwich. The highest value but one in the year for atmospheric pressure occurs at both sites on March 8: there is a probability of the sky being more clear at Greenwich at this time under the influence of the N.E. wind than it is at Newport. On the 26th a minimum value for pressure occurs at both sites, the N.E. being exchanged for S.W. on this day.

A short period of S.W. now intervenes in the midst of a long period of N.E.; or, in other words, two long periods of N.E. are separated by a short one of S.W. The accession of S.W. introduces a period of increasing cloud; and the result as regards temperature is a falling off of the increment-rate. S.W. preponderates during March 26–April 9, and cloud increases during April 1–13. Increase of cloud does not commence immediately upon the change of wind, neither does the alteration in the rate; but the rate now falls off simultaneously with the increase of cloud (a slight smoothing of the numbers as they stand in the Table would show this to be strictly correct), and continues to decline down to April 9 at Greenwich, and April 11 at Newport. An increasing rate then commences at Greenwich on the same day that the wind returns to N.E., viz. April 10, and four days before the diminution of cloud; at Newport the increasing rate occurs two days after the change of wind, and two days before the diminution of cloud. The rate now increases with the return of the N.E. wind.

Greenwich.	Newport.	Dew-point.	Date.
+·19	+·23	+·20	March 26. S.W.
·23	·24	·21	
·23	·25	·23	
·23	·24	·24	
·23	·26	·24	
·21	·24	·23	
·21	·23	·20	April 1.
·20	·22	·19	
·17	·20	·16	
·16	·18	·13	
·12	·16	·10	
·11	·14	·08	
·08	·13	·05	
·06	·11	·03	
·05	·11	·02	April 9.
·06	·10	·01	N.E.
·08	·10	·01	
·11	·11	·02	
·13	·11	·02	April 13.

It would be interesting to know on what day the sky begins to clear at Greenwich; it appears that it does so earlier than at Newport, and that Newport feels the influence of the clearer sky *at Greenwich*; and this makes it probable that the wind changes to N.E. at Greenwich earlier than it does at Newport. We have the fact that the rate falls off contemporaneously with increase of cloud on April 1 and with S.W. wind. The increased cloudiness does not depend upon increase of vapour from the south. The S.W. wind prevails on March 26: the sky continues to get clearer, the rate in temperature increases, and the rate for dew-point increases, until March 31 or April 1. Then the rates at Greenwich, at Newport, and in dew-point all diminish, and at the same time cloud increases. The increase of cloud must be caused by *cold*—by an upper current from the north immediately above the level of the clouds, which condenses the vapour it approximates to. It is remarkable that the dew-point-increment should subside to 0 under a S.W. wind, having previously been rising rapidly under a N.E. It would appear that previously (in the preceding period) the N.E. is accompanied with an upper S.W. current, as this would account for the increase of vapour; and that afterwards the S.W. is accompanied with an upper (cold) north current, as the vapour could not be condensed whilst it was increasing in temperature and not increasing in quantity. Cessation of increase of vapour might result from active deposition (in the form of snow probably) in some near neighbourhood. There is an actual outflow of air at the sites, at this time, exceeding the inflow, as well as an outflow of vapour nearly or quite equal to the supply. Deposition must put the vapour in motion; and the air and vapour, whilst intermixed, cannot move in perfect independence of one another. Such atmospheric movement must be attended with accumulation of air at the point of attraction; and this accumulation, like a heaping up of water, can proceed only to a limited extent. If the deposition be in northerly latitudes, the resulting atmospheric current will be from the S.W. The respective specific gravities of the warm south atmosphere, and of the cold north atmosphere will account for a lower N.E. current with an upper S.W. current; but some other explanation is required for the reversed order. When a current from the north overrides one from the south, this, apparently, must be occasioned by a derangement of level. At this period of the year the increasing supply of vapour in the south is, as it were, too great for the temperature of the earth and lower strata of the atmosphere in the north; condensation of vapour and accumulation of air, therefore, take place below, and the atmosphere increases in elevation, it overtops and then overflows the atmosphere on its southern side which has been drawn upon, and thus it flows southward. Before the atmosphere can be at rest in the upper and in the lower regions, there must be a perfect level surface to the whole atmospheric mass, as well as equilibrium of weight in the mass; and as any circumscribed portion of atmosphere must needs be always changing, both in bulk and in weight, in consequence of perpetual changes of temperature and of increase or decrease of vapour, the atmosphere never can be equalized in either sense. The hillocks are always flowing into the valleys, and hillocks and valleys are always being formed by the local alterations that take place in the atmospheric bulk; and at the same time the atmosphere is always changing (in one sense in some places and in the other sense in other places) in its specific gravity, through alterations in temperature and in the quantity of vapour. A maximum value for atmospheric pressure occurs at Greenwich on March 28, and at Newport on 29, 30. This may be attributed to the *double* pressure, *i. e.* the pressure of the northern atmosphere added to that of the southern atmosphere. The values then fall to a minimum on April 7 at Newport, and on April 8 at Greenwich. This makes it appear that the return of the N.E. on the 10th is owing to the small pressure from the south. The minimum value at Newport is 0·084 in. below

Newport *mean*; that at Greenwich is 0·093 in. below Greenwich *mean*. The fall from the maximum to the minimum is ·023 at Newport, and ·042 at Greenwich.

In the period April 10–May 17, the increase of temperature caused by the changed declination of the sun is very conspicuous at Greenwich, so also is that dependent on the state of the sky. The dependence of temperature on wind is shown clearly in the Newport column. We come now to the longest period of continued N.E. wind that is experienced during the year; and this period includes the *maximum* value for this quadrant. N.E. pre-

Greenwich.	Cloud.	Newport.	Date.
+·06		+·11	
·05		·11	
·06		·10	April 10.
·08		·10	
·11		·11	
·13		·11	
·17	Decreases.	·11	
·17		·12	
·17		·12	
·19		·12	
·21		·13	
·21		·13	
·22		·13	
·21		·13	
·21		·13	
·21		·13	
·20		·14	April 24.
·22		·13	
·26		·14	
·27		·13	
·31	Increases.	·14	
·33		·14	
·32		·15	
·32		·14	
·31		·15	
·27		·16	
·26		·15	
·22		·17	
·18		·18	
·17		·18	May 7.
·14		·20	
·12		·22	
·13		·22	S.W.
·15		·24	
·16		·25	
·17		·26	
·20		·26	
·24		·27	
·26		·28	
·25		·28	May 17.
·24	Decreases.	·27	
·25		·27	
·23		·26	

vails during April 10–May 7, S.W. gaining the ascendency on May 10. The N.E. stands at its *maximum* on the four days April 17–20. Cloud, which begins to increase on April 2 (during S.W. prevalence), continues to increase until four days after the N.E. sets in on the 10th; diminution of cloud then ensues during (with a slight interruption) April 14–27, and then increases until May 17. And this increase may be attributed to increase of vapour, and probably to a high-level S.W.; for S.W. begins to increase on April 24 (and an increase of cloud is recorded for the 25th), and the dew-point on the 28th rises more than temperature does, and this excess for dew-point increases to 0°·07 on May 4. We have in this period the *maximum* increment-rate both at Greenwich and at Newport. At Greenwich the increment-rate goes on increasing down to April 29—the *maximum*, ·33 (·325), appearing on this day. The rapidly increasing power of the sun at the equinoctial period must of course help greatly in producing this rapid rate; but the decrease of cloud during April 14–27 must be influential in continuing the increasing rate down to April 29. The degree of cloudiness, though at a maximum, is considerably below the *mean* on the 14th, and on the 27th it is lower than on any day subsequent to the middle of September. The increment-rate falls off on April 30 at Greenwich, cloud commencing a period of increase on April 28. The rate falls from ·33 on April 29 to ·13 on May 10. On May 10 the S.W. returns, and this brings up the rate from ·13 to ·26 on the 16th—cloud being still on the increase. Cloud, however, though increasing until May 17, does not reach so high a value as the maximum of April 13; and the increasing cloud therefore does not prevent the S.W. influence from manifesting itself. At Newport the increment-rate increases all through this period, the increase commencing two days later than it does at Greenwich. The increase of the rate is not nearly so great as at Greenwich, during the early part of the period, whilst cloud is decreasing; and then, instead of coming to a maximum when cloud begins to increase, the rate continues increasing in the same proportion as before, and when the S.W. returns there is still the same proportionate increase of rate, and under the influence of the S.W. it reaches the *maximum* on May 16 whilst cloud is still increasing, the Greenwich rate reaching a maximum on this day also. We have in the Newport column a regular increase of temperature, resulting from the progressive heating of the sea, instead of the local alternations observed at Greenwich; and the increment-rate culminates sixteen days later than it does at Greenwich, under the influence of a S.W. wind. The values for S.W. *rise* continuously from April 23.

At Greenwich
the rate increases by ·28 in 20 days, April 10–29.
„ decreases ·21 10 „ April 30–May 9.
„ increases ·14 7 „ May 10–16.

At Newport
the rate increases by ·18 in 35 days, April 12–May 16.

On April 11, Greenwich is 0°·94 below Newport; on May 16, Greenwich is 0°·70 above Newport. This period of N.E. wind includes the well-known Blackthorn Winter, which is supposed to be characterized by a great reduction of temperature. The progress of temperature at Greenwich fully establishes the fact that a great rise in temperature actually takes place. Even the *rate* of increment increases, and temperature rises 3°·53, during the last fifteen days of April*. The barometer is at a low minimum on April 7 at Newport, and on the 8th at Greenwich, having fallen to this low point whilst the N.E. was increasing and the S.W. declining: the Newport minimum is ·084 in. below the Newport *mean*; the Greenwich minimum is ·093 in. below the Greenwich *mean*. The N.E. becomes the prevailing wind on April 10. During April 17–20 N.E. is at its *maximum*, and the barometer attains a maximum reading on April 18–19 at Newport, and April 20 at Greenwich—the Newport maximum being ·004 in. above Newport *mean*, and the Greenwich maximum ·008 in. above the *mean* of that place. The 7th of May is the last day of N.E. preponderance: the barometer attains a minimum on May 6–7 at both places. The barometer then rises ·018 in. and to a maximum during the following six days at Greenwich; and it rises ·024 in. to a maximum during the following seven days at Newport: S.W. is increasing at this time, and gains the ascendency on the 10th.

The S.W. having returned on May 10, it continues then to be the prevailing wind to the last day of August. The effect of the change was to send up the increment-rate to the *maximum* at Newport, and to a high maximum at Greenwich, notwithstanding some increase of cloud and a considerable retardation of the sun's progress; but this continued only for a few days. On May 18, cloud begins to decrease; and though this suffices to keep the rate up to nearly the same mark at Greenwich, it falls off considerably at Newport. The value for cloud on June 1 is a very low one—the lowest minimum but one in the year.

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* The real conditions of the Blackthorn Winter and of St. Martin's Summer, as ascertained at Newport, have been stated in the 7th Number of ‘Proceedings.’

Greenwich.		Newport.		Date.
Mean ·234	+·24	Mean ·251	+·27	May 18.
	·25		·27	
	·23		·26	
	·23		·26	
	·22		·24	
	·24		·23	
	·23		·23	
	·23		·20	
Mean ·229	·21	Mean ·169	·20	
	·23		·18	
	·24		·18	
	·23		·16	
	·23		·16	
	·24		·15	
	·22		·15	June 1.

Cloud increases during June 2–13. The rate falls off a trifle at Greenwich at this period, and it remains stationary at Newport. The question may be asked, Why does the rate now remain stationary at Newport whilst cloud increases, seeing that the rate fell off just before whilst cloud was decreasing? The answer is, the S.W. wind remained almost constantly at the same value during May 20–30, and therefore did not tend to *augment* the rate; the slackening pace of the sun's progress at this time was more than equivalent for the diminishing cloud; and the balance was shown in a reduction of rate. During May 31–June 10 the values for S.W. rise considerably and those for N.E. fall considerably; and the tendency of this to raise the rate equals the tendency that more cloud and a slower sun have to reduce it. Why does the rate now fall off at Greenwich with increasing S.W., seeing that the rate remained stationary just before with stationary values for S.W.? Because cloud increases, whilst in the prior instance cloud

Greenwich.		Newport.		Date.
Mean ·177	+·20	Mean ·15	+·15	June 2.
	·18		·15	
	·17		·14	
	·16		·15	
	·17		·15	
	·18		·14	
Mean ·172	·18	Mean ·15	·15	
	·17		·15	
	·16		·14	
	·17		·15	
	·17		·14	
	·18		·15	June 13.

The first column in this Table gives the daily increment, or decrement, for Greenwich. The second column gives the daily increment for Newport. The third gives the daily increment in the dew-point at Newport. The fourth gives the difference between temperature and dew-point at Newport.

Date.	Greenwich.	Newport.	Dew-point.	Difference.	Cloud.
	+·18	+·14	+·14	8·42	Increasing.
	·18	·15	·14	8·43	
June 9.	·17	·15	·16	8·42	
	·16	·14	·16	8·40	
	·17	·15	·17	8·38	
	·17	·14	·17	8·35	
June 13.	·18	·15	·18	8·32	
	·19	·15	·18	8·29	Decreases.
	·17	·15	·18	8·26	
	·17	·16	·19	8·23	
	·17	·16	·18	8·21	
	·19	·17	·18	8·20	
	·21	·17	·19	8·18	
	·22	·17	·18	8·17	
	·22	·18	·18	8·17	
	·20	·17	·18	8·16	
June 23.	·20	·16	·17	8·15	
	·17	·16	·17	8·14	Increases.
	·18	·15	·17	8·12	
	·16	·13	·16	8·09	
	·15	·13	·16	8·06	
	·11	·11	·15	8·02	
	·06	·10	·14	7·98	
	·03	·09	·13	7·94	
July 1.	·02	·08	·13	7·89	
	·04	·08	·13	7·84	
	·06	·07	·12	7·79	
	·07	·06	·11	7·74	Decreases.
	·06	·05	·12	7·67	
	·05	·06	·10	7·63	Increases.
	·04	·04	·10	7·57	
	·05	·05	·09	7·53	
	·08	·04	·09	7·48	
July 10.	·08	·03	·09	7·42	
	·08	·03	·08	7·37	
	·05	·03	·07	7·33	
	·02	·02	·06	7·29	
	·00	·02	·06	7·25	
	—·01	·02	·05	7·22	
	—·03	·02	·05	7·19	
	—·02	·03	·05	7·17	
	—·04	·03	·05	7·15	
	—·05	·03	·04	7·14	
	—·04	·05	·04	7·15	
	—·04	·05	·04	7·16	
July 22.	—·01	·06	·04	7·18	
	+·01	·07	·04	7·21	Decreases.
July 24.	·02	·07	·04	7·24	
	·04	·08	·03	7·29	
	·07	·09	·03	7·35	
	·07	·07	·04	7·38	
	·07	·08	·02	7·44	
	·05	·07	·02	7·49	
	·05	·06	·01	7·54	
	·02	·05	·02	7·57	
August 1.	·02	·03	·00	7·60	
	·01	·02	·00	7·62	
	·00	·02	·00	7·64	
	—·01	·00	—·02	7·66	
	—·04	—·02	—·02	7·66	

decreased. Newport temperature is more controlled by the direction of the wind; Greenwich temperature is more controlled by the amount of cloud.

The increment-rate for dew-point exceeds that for temperature, from June 9 to July 24. This excess commences on June 9 at Newport; but at Greenwich the increment in temperature is greater than it is at Newport until June 28, and the dew-point-increment, as observed at Newport, does not exceed that for temperature at Greenwich until June 27. The dew-point-excess continues until July 20 at Newport, and until July 24 at Greenwich. During June 14–28, cloud diminishes; it does so on July 4–5 also; and, with the exception of these two intervals, cloud increases until July 22, this increase having commenced on June 2. This increase of cloud is remarkable. The amount of cloud declines, with alternating curves, from January 19 to June 1, falling below the *mean* on March 6; and on June 1 the amount of cloud is not much above the *minimum*; after June 1 cloud increases, crosses the *mean* line on July 18, and remains above the *mean* until the 27th; the values then decline (with one intervening period of increase) to the *minimum* on September 4, and then the *mean* is not reached again till September 28. Mere increase of vapour with increase of temperature is nothing remarkable. The rule hitherto has been for temperature to rise more quickly than the dew-point, the rise in temperature at Newport on June 9 being 17°·96 from the *minimum*, whilst the rise in dew-point is 14°·44; but on July 24 the rise from June 9 is 4°·18 in temperature and 5°·36 in dew-point. This accounts for the increase of cloud; perhaps the inequality in the advances of temperature and dew-point may be accounted for also. The sun's position in the ecliptic alters but little during this period; he may be said to stand vertical to the parallel 22° during nearly two months, inasmuch as for 56 days (May 25–July 19) he never varies more than 1⅓° from 22¼° N.; under these circumstances the quantity of vapour produced must be great in proportion to the increase of temperature in these latitudes. More vapour must be produced in a given time, say from June 1 till towards the end of July, than at any other period of the year, on the north side of the line; but temperature increases most rapidly when the sun's progress is rapid, and not at the solstitial period. Thus increment abates earlier in temperature than in the dew-point. The humidity of the atmosphere increases from 73 on June 8 to 77½ on July 22. The increment-rate for dew-point falls off by very equal steps as the *maximum* is approached—that is to say, from June 16 to August 3; but temperature progresses more irregularly, according to the state of wind and cloud; and thus the dew-point-increment is at times great, compared with that for temperature. During June 8–July 26, S.W. keeps to a high value and without any great variation; so that this tends to maintain a high temperature rather than to raise it higher. During June 14–23, cloud diminishes, and some increase of rate is observable at both places, although the value on the 23rd day is not so low as the minimum on June 1; probably the diminution of cloud is greater at Greenwich than at Newport, and this tells upon both places. After this ten days' interval, cloud increases again, and the rate falls off both at Greenwich and at Newport; and this goes on till the rate is reversed at Greenwich, reaching a maximum negative quantity on July 19; and at Newport it falls to almost 0 on July 16. On July 23, cloud begins to diminish, and this is accompanied by increasing temperature at Greenwich, and an increasing increment at Newport; the difference thus made in the rate at Greenwich is ·12, and at Newport it is ·07. The law holds very constantly, that the changes in temperature caused by differences in the amount of cloud are much greater at Greenwich than at Newport; it is possibly the case, however, that this depends upon the variations in the amount of cloud being greater at Greenwich. The diminution of cloud last noticed, which does not go to so low a point as that of June 23, continues until August 5. S.W. makes another rise during July 30–August 4, and stands at its *maximum* during August 4–7. Temperature attains its *maximum* on August 3, at both places. The N.W. wind, though much below the S.W. in frequency, is above its *mean* during nearly the whole of this long period (from June 14 until August 2), and it stands at a maximum on June 19–24, and on July 10–11; on these occasions it is not unlikely that the sky is clearer at Greenwich than it is at Newport.

Whatever the cause may be for temperature culminating on August 3, the changed position of the sun suffices to account for decline after that date. Decrement would take place earlier probably, if the sky became more cloudy; cloud does increase on August 6, and the S.W. declines on the 8th. The increase of cloud may now be the *effect* of lower temperature; and it appears that it is so, because the *decrement*-rate for dew-point exceeds that for temperature; it therefore does *not* depend upon increase of vapour,—although Newport does not show such a reduction of temperature as to account for condensation and diminution of vapour, as Greenwich does. Cloud increases during August 6–17;

Greenwich.	Newport.	Date.
−·04	−·02	
·05	·02	August 6.
·04	·03	
·05	·03	
·05	·05	
·05	·04	
·07	·05	
·09	·06	
·11	·06	
·12	·06	
·11	·06	
·11	·07	
·11	·07	August 17.

temperature during this interval declines at the rate ·05 at Newport, whilst the decrement-rate for dew-point is ·07; at Greenwich the decrement-rate for temperature is ·08. The deposition which produces the reduction in the dew-point noted, takes place probably in higher latitudes than that of Newport or Greenwich. Upon deposition taking place, decrement in dew-point is then observed on August 4; increase of air-pressure and of atmospheric pressure on the 7th; decrease of S.W. on 8–16, increase of N.W. 9–16. Deposition in the north puts the vapour in motion from the south, where vapour abounds, and the vapour carries the air with it; the air which is drawn to the place of deposition cannot remain there in excess, and it flows back to the region where deficiency has been produced; and this movement is manifested in the N.W. wind, and this N.W. wind is a vapour-drained atmosphere; consequently the N.W. is accompanied by increase of air and diminution of vapour. According to this view, there ought to be diminishing atmospheric pressure noted at the time the atmosphere is supposed to be accumulating in the north. Atmospheric pressure does fall from 29·957 in. on July 27, to 29·932 in. on August 6 at Greenwich, and from 29·978 in. to 29·942 in. on the same dates respectively at Newport, and the S.W. increases during July 30–August 4. It would appear from this that we are able to fix the date of this commencing autumnal deposition in the north at July 27 or between this and the 30th. If the deposition had occurred in southern latitudes, this might produce N.W. wind at the sites, but then it is to be supposed that a N.W. *thus* produced would be accompanied by a falling barometer, and it would not be preceded by increase of

S.W. The return current from the north is here represented as a low-level current, though a similar return current was represented as being, in the spring season, an upper current. This is perhaps quite consistent. In the spring, the increasing vapour becomes too much for the existing temperature of the lower atmospheric strata; the supply-stream to the north being thus below, the overflow proceeds to the south at a high level. In the fall of the year, the temperature of the upper atmospheric strata becomes too low for the quantity of vapour existing there, the supply-stream therefore is strong in the higher strata, and the surplus air forces its way back below. The supply-stream which is near the earth will have acquired much of the earth's motion eastward on reaching the place of deposition; but that at a high level would not do so; and therefore the air which accumulates in the latitude of deposition would be more likely to drift to the westward before acquiring much motion southward.

In the period August 18–September 4, there is something remarkable both in the correspondence and in the diversity of the decrement-rate at the two places. The whole period is characterized by continuous diminution of cloud; it is divisible into two parts, distinguished by the different wind-tendencies. During the first part, including August 18–25, the four quadrants for wind keep nearly to the same respective values, the N.E. rising somewhat, however, during the last four or five days, and the S.W. falling on

Greenwich.	Newport.	Date.
—·11	—·07	August 17.
·12	·06	
·11	·07	
·11	·07	
·11	·07	
·11	·07	
·11	·07	
·11	·08	
·11	·07	August 25.
·14	·09	
·15	·09	
·17	·11	
·19	·11	
·20	·12	
·20	·14	
·20	·13	
·20	·14	
·20	·14	
·20	·14	September 4.
·18	·14	
·17	·13	

the last two. The decrement-rate during the first part of the period keeps to the same value at each site respectively, that for Greenwich being ·11, and that for Newport ·07, whilst the rate for dew-point is ·10. The meteorological progression, therefore, remains pretty much as it was at the conclusion of the foregoing period, temperature declining in correspondence with the declination of the sun. The diminution of cloud is not as yet rapid. In the second part of the period the decrement-rate increases at both places, being at Greenwich ·19, and at Newport ·12, on the average, whilst for dew-point it is ·13. The decrement-rate for temperature, therefore, now keeps pace with that for dew-point at Newport, whilst at Greenwich it is much in excess of that for dew-point. Cloud diminishes rapidly during this part of the period it falls to the *minimum* on September 4, and this minimum is considerably below any other in the year. S.W. declines rapidly, N.E. increases rapidly, and is the prevailing wind after August 31, reaching a high maximum on September 5. The direction of wind does not seem sufficient to account for the decrement in temperature so much exceeding that for dew-point at Greenwich. The effect of clear sky is now reversed, it tends to lower temperature, and *this* effect is more marked at Greenwich than at Newport. The enclosed thermometer, which indicates the heat received from the sun's rays during the day, attains its *maximum* reading on September 3, radiation from this thermometer being intercepted as well as from the exposed thermometer. *Atmospheric* temperature falls from 62°·21 on August 3 to 58°·67 on September 3 at Greenwich, and from 61°·37 to 59°·12 at Newport. Atmospheric pressure is at the *maximum* on September 3, at both places.

September 5–October 8 is a period of daily increasing cloud, with the exception of the two days September 16 and 17. Considerable variations occur in wind during this time, but it being an equinoctial period, the progress of temperature appears to be governed mainly by the progress of the sun. At the commencement of the period the N.E. quadrant stands the highest in the scale, and the S.W. the lowest. The values for S.W. increase during September 8–October 4; and this quadrant gains the ascendency on September 16, and keeps it beyond the limit of the period. The N.W. begins a period of increase on September 30. At first, when cloud begins increasing, the decrement-rate falls off, the high values for N.E. declining after the 6th; but though the rate falls off, this does not fall lower than to ·12 at Greenwich, and ·10 at Newport, the respective *means* for this rate being ·16 and ·12. The rate increases again on the 10th and 11th, shortly after S.W. begins to rise. This increase of rate proceeds to a high value on September 19 at Greenwich, and on September 28 at Newport, and then declines again to a small extent after these dates, increase returning on the 30th, the day on which N.W. begins to increase. The values for cloud rise above the *mean* on the 28th. It is to be observed that the high rate of decrement at Greenwich on the 19th is, considering the difference in the averages, considerably exceeded at Newport on the 23rd. Greenwich, therefore, shows the influence of cloud in keeping up the temperature above what it would be with a clear sky during the rapid progress of the sun southward. A difference in the effect of change of wind is also observable, the increase of rate upon the increase of N.W. being by far the

Greenwich.	Newport.	Date.
—·18	—·14	September 5.
·17	·13	
·15	·12	
·13	·11	September 8.
·12	·10	
·13	·10	
·13	·11	
·15	·10	
·14	·11	
·14	·13	
·16	·13	
·16	·16	September 16.
·19	·17	
·21	·19	
·22	·20	
·21	·21	
·21	·23	
·19	·23	
·18	·23	September 23.
·18	·23	
·18	·23	
·18	·23	
·18	·21	
·15	·21	
·16	·20	
·17	·21	September 30.
·17	·20	
·19	·21	
·19	·21	
·22	·22	October 4.
·23	·24	
·25	·24	
·25	·26	
·27	·27	October 8.

greater at Greenwich. Cloud now impedes the reduction of temperature, clear sky having accelerated it in the foregoing period. The increase of cloud results from reduction of temperature; vapour decreases, but not so quickly as temperature. Rain increases (with the exception of three days) continually from September 4 until October 3, and October 8 gives the *maximum* fall for one day. Atmospheric pressure sinks from the *maximum* on September 3 at both places, to the *minimum* on October 4 at Newport, and October 5 at Greenwich.

Cloud diminishes during October 9–20, and we get high decrement-rates—much higher than at the equinox. But although cloud diminishes, it is on the 20th above the *mean*, and on the 13th it is considerably above the value for September 23. On October 13 the *maximum* decrement occurs at Newport; and at Greenwich a maximum value occurs on the 12th; but the decrement is scarcely so great here as at Newport, though the *mean* value is highest at Greenwich. The conditions of wind account for the rates being higher now than they were at the equinox. Winds from the north side of the compass are above their *mean* during October 9–21, and they increase from September 29 until October 18. At the equinox, S.W. is on the increase and northerly winds are considerably below their *mean* value. After the 13th the rates fall off, northerly winds lessening in frequency; and the rate falls off somewhat more at Newport than at Greenwich. Atmospheric pressure attains a maximum at both places on October 20.

Greenwich.	Newport.	Date.
—·25	—·26	
·27	·27	
·29	·28	October 9.
·26	·29	
·27	·30	
·29	·29	
·27	·30	October 13.
·26	·30	
·26	·29	
·25	·28	
·26	·27	
·25	·27	
·23	·25	
·28	·24	October 20.
·28	·23	

Cloud increases after October 20, and reaches as high a point as 90 in 100, having risen from 0 in the scale on September 4 to

86 on October 8, and then fallen to 57 on October 20, then rising to 90 on November 7. At the latter part of the preceding period, when cloud was diminishing, the rates declined; they continue to decline for some days in this period of increasing cloud; but at Greenwich the rate increases on the last two days, and rises abruptly above the Newport rate, though the rate falls after the 21st at both places. Cloud probably falls to a lower minimum at Greenwich on the 20th or 21st than at Newport, and the amount of cloud then probably continues lower for some days.

Greenwich.	Newport.	Date.
—·28	—·23	October 21.
·27	·22	
·28	·20	
·28	·20	
·27	·18	
·26	·17	
·23	·16	
·20	·16	
·20	·14	
·17	·14	
·18	·15	
·18	·14	November 1.
·18	·16	
·19	·16	
·21	·17	
·21	·19	
·25	·20	
·30	·21	November 7.
·31	·23	
·33	·24	
·30	·24	

The difference of rate is as much as ·09 on the 25th and 26th. The rate begins to increase again at Greenwich on October 31, and at Newport on November 2, and it increases rapidly at both places, but more rapidly at Greenwich than at Newport. An explanation of this increasing and high rate, during a period of high and increasing values for cloud, may be found in the changes of wind. Easterly winds increase and westerly winds decrease after October 22. The S.E. rises above its *mean* value on October 26, and attains its *maximum* on November 3. N.E. rises above its *mean* on November 5, and reaches a maximum on the 12th. Just about this last date decrement is at a maximum at Newport, and at Greenwich the *maximum* rate is attained on the 9th. The direction of the wind seems to account sufficiently for the great decrement; but something more is needed to account for the rate being so much higher at Greenwich than at Newport, and higher than it had been on October 13. We have not the facts before us to explain this; but it is probable that it depends upon the N.E. being more prevalent at Greenwich than at Newport. The S.W. is considerably below its *mean* on November 9th, and the N.E. is above *mean*, but still the S.W. stands considerably higher in the scale of frequency than N.E. does, at Newport; probably N.E. stands highest at Greenwich on the 9th. High values for N.E. would be likely to produce a clearer sky, moreover; and this may cause the sudden increase of rate at Greenwich on the 6th. There is in fact a diminution of cloud on the two days 8th and 9th, at Newport.

The values for cloud remain almost stationary during November 8–16, and the decrement-rate is stationary at Newport until the 14th. N.E. declines on the 14th, and the rate declines. At Greenwich the rate declines from the second day of this period; and if it be supposed that the N.E. is more frequent at Greenwich than at Newport at this time, we must then suppose that the frequency diminishes at Greenwich on the 10th, instead of the 14th, as at Newport. The decrement-rates are high throughout this period, and the *maximum* occurs at Greenwich; N.E. is above its *mean* throughout. The period includes November 11—St. Martin's day. Greenwich therefore shows "St. Martin's Summer" to be remarkable for the most rapid decline of temperature that occurs in the year. The other characteristics of these "halcyon days" are great cloudiness of the sky, great humidity of the atmosphere, and great stagnation of the atmosphere*. Rain is exchanged for cloudiness and humidity; on November 11 the

Greenwich.	Newport.	Date.
−·31	−·23	November 8.
·33	·24	
·30	·24	
·30	·24	
·28	·24	
·27	·24	
·27	·22	
·27	·22	
·24	·21	November 16.

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* A four-years' record of the force of wind at Newport shows November 13–22 to be the ten days of minimum force; and the force falls from 2·30 on October 22 to 1·47 on November 11, and to the *minimum* 1·30 on November 16.

fall is ·088 in., the *mean* value being ·090 in.; on October 25 the fall is ·171 in.; and the values diminish from this date to November 8.

We come now to a period in which the rate is not only reduced, but even reversed; decrement is exchanged for increment. Increment commences at Greenwich on November 26, and at Newport on December 5. The sky is very clouded at this part of the year, the values for cloud ranging between 90 and 97 during the period November 16–December 11, December 11 giving the highest amount. Winds from the west half of the compass are, during this period, by much the most frequent; those from the north, south, and east semicircles coming in this order of frequency. The N.W. and S.W. quadrants interchange, and are generally nearly on a par; the direction is therefore probably for the most part near to the west point. The main fact illustrated by the period and at both places is, that decrement becomes greatly abated with westerly winds and a cloudy sky, though the period may be divided into groups which do not all show variations in rate in accordance with the general law. The highest + quantity for temperature at Greenwich diverges only by two days from a high maximum

Greenwich.	Newport.	Date.
−·24	−·21	November 16.
·21	·19	
·18	·19	
·16	·17	
·13	·16	
·10	·16	
·09	·16	
·07	·15	
·04	·14	
·00	·14	
+·05	·12	November 26.
+·05	·12	
+·08	·09	
+·08	·09	
+·05	·06	
+·03	·04	
−·01	·03	
·02	·01	
·04	·00	
·06	+·01	December 5.
·11	+·02	
·13	+·01	
·17	+·01	
·18	·00	
·17	−·02	
·16	·04	December 11.

for cloud on the 26th; and the lessening of these + quantities is attributable to high and increasing values for N.W. The highest + quantity at Newport anticipates by one day a change from N.W. to S.W. during increasing cloud. The comparatively rapid decrement at Greenwich at the close of this period may be occasioned by the N.W. continuing longer there than at Newport, the sky consequently getting clearer there, instead of more cloudy as it does at Newport after the 5th. The N.W. prevails at Newport during November 24–December 6, and is at its *maximum* value on November 30–December 2. There is probably during this period a N.W. blowing in the more northern parts of the country, whilst a S.W. blows in the more southern parts, the main tendency being westerly. A great difference commences here in the progression of temperature at the two places, decrement being considerably greater at Greenwich than at Newport during several weeks after the beginning of December. Atmospheric pressure is at a maximum on December 9 at Newport, and on 9–10 at Greenwich; this maximum may be the effect of a current from the north side of west meeting another proceeding from the south side of west at a line between the two places. S.E. increases after the 3rd, and N.E. after the 16th of December. The *maximum* degree of humidity occurs on December 3.

During a great part of the period December 12–January 10, N.W. and S.W. are still the prevailing winds alternately; but they each stand considerably lower in the scale than they did in the preceding period, and N.E. stands much higher. Wesetrly winds stand much lower, and northerly winds stand much higher. It may be inferred that these N.W. winds are generally near to the north point, instead of near to the west point as before. After December 11, cloud diminishes until December 28; and after the 28th, cloud increases for the rest of the period, but not reaching so high a point in this period as on December 11 by a good deal. The decrement-rate increases at both places until the shortest day; and on some days the decrement is as great at Newport, or nearly so, as at Greenwich, where the rate is more variable. The sun may now be considered to be stationary. On the 21st, cloud is decreasing, N.W. prevails, and is rising, and is considerably above its *mean*; N.E. is rising and above its *mean*; northerly winds are, of course, rising and above their *mean*. These conditions of cloud and wind account for a high rate, and, when compared with the conditions that obtained at the end of November and beginning of December, which raised temperature remarkably, they are sufficient perhaps to account for the great decrement that is now noted. After December 20 the rates decline; and this may be attributed, in some measure at least, to the fact that temperature has at this date descended from its previous abnormal elevation; but, at the same time, both N.W. and N.E. increase with lessened rapidity. On December 28 a considerable diminution of rate may be observed, and on this day northerly winds begin to decline, N.E. declining on the 26th, S. and S.E. rising; and on the 29th cloud begins to increase. Decrement subsides to 0 on January 5 at Newport, and on January 10 at Greenwich; cloud is now on the increase; the S.W. gains the ascendency on the 5th, and temperature increases at Newport on the 6th. At Greenwich, January 9 and 10 give the *minimum*. There is a great difference in the rate as shown for Greenwich and as shown for Newport in this period. The difference of temperature at the two sites on December 2 is only 0°·28, and on January 10 it is

Date.	Greenwich.	Newport.	Difference.	
	—·16	—·04	·12	
December 12	·13	·06	7	Cloud decreases.
	·14	·09	5	
	·15	·12	3	
	·17	·13	4	
	·17	·17	0	
	·20	·18	2	
	·20	·20	0	
	·24	·22	2	N.W.
	·25	·22	3	
December 21	·24	·21	3	
	·25	·21	4	
	·23	·20	3	
	·23	·18	5	
	·22	·16	6	
	·19	·14	5	
	·16	·11	5	N.W. and N. max.
December 28	·14	·09	5	
	·11	·07	4	Cloud increases.
	·10	·05	5	
	·13	·04	9	
	·14	·02	12	
	·16	·02	14	
	·14	·00	14	
	·11	·01	10	
January 5 ...	·12	·00	12	S.W.
	·11	+·01	12	
	·10	·00	10	
	·08	+·01	9	
	·05	+·02	7	
January 10...	·00	+·02	2	

3°·12. This may arise from the sky being clearer at Greenwich; but there is an additional reason now for the rate being higher at Greenwich, after the first few days at least. A line drawn from the north of North Britain to Greenwich would proceed from a point between N. and N.W., and a line drawn parallel to this through Newport would pass along the Irish Channel and the Atlantic. This may account for the Greenwich rate exceeding the high Newport rate during the time of the N.W. preponderance in this period. The greatest difference occurs on January 2–3; and the N.W., whilst falling, still equals the S.W. (which is beginning to rise) on the 4th. The N.W. rises above S.W. on December 19, and on this day the difference begins increasing. The S.W. preponderates on January 5; but N.E. rises at this time as well as S.W., S.W. and N.E. being now the two most prevalent winds instead of S.W. and N.W. Under these circumstances there is a strong probability that N.W. is exchanged for N.E. at Greenwich, instead of for S.W. as at Newport; or at any rate it is probable that N.E. is *more* prevailing, and S.W. *less* prevailing than they are at Newport. This would fully account for decrement being great at Greenwich on January 6 whilst increment occurs at Newport.

When the cause of a known occurrence is not declared and cannot for the time be ascertained, it is warrantable perhaps to offer an explanation founded on hypothesis.

TABLE I. Daily progression of Temperature at Greenwich.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
1	−1	−2	0	−1	+1	+1	+2	+2	+3	+5	+2	+4	0	−2	0	0	−2	−2	−2	−1	−1	−1	0	+2
2	−2	−3	0	−1	+1	0	+2	+2	+3	+5	+2	+3	+1	+2	0	0	−2	−3	−2	−1	−2	−1	0	+1
3	−1	−3	+1	+1	+1	0	+2	+2	+3	+5	+2	+1	+1	+2	0	0	−2	−3	−2	−1	−2	−2	0	+1
4	−1	−3	0	+2	0	−1	+1	+2	+3	+4	+2	−1	0	+2	0	−1	−2	−2	−2	−2	−2	−2	−1	−1
5	−2	−2	+1	+3	+1	0	+2	+2	+2	+3	+2	−1	+1	+2	0	−1	−2	−2	−2	−2	−2	−2	0	0
6	−1	−2	+1	+3	+1	0	+1	0	+2	+2	+1	−2	0	+1	−1	−1	−2	−1	−2	−4	−3	−2	−1	−1
7	−1	−2	0	+2	+1	+1	+1	0	+2	0	+2	0	+1	+1	0	−1	−1	−1	−3	−4	−3	−2	−2	−1
8	−1	−1	0	+1	+1	+1	0	0	+1	0	+2	+3	0	−2	−1	0	−2	0	−3	−4	−3	−3	−1	−3
9	−1	+1	0	0	+1	+1	+1	−1	+1	−2	+2	+4	+1	0	0	+1	−1	−1	−3	−3	−3	−3	−2	−4
10	0	+1	0	−1	+1	+2	0	−1	+1	−2	+1	+3	+1	+1	−1	0	−1	0	−2	−2	−3	−3	−2	−3
11	0	+1	−1	−2	+2	+3	+1	−1	+2	−1	+2	+3	+1	0	0	0	−1	−1	−3	−2	−3	−3	−1	−3
12	+1	+1	0	−2	+2	+3	+1	−1	+1	0	+1	+3	0	+2	−1	−1	−2	−1	−3	−2	−3	−3	−2	−1
13	+1	+1	0	−1	+2	+2	+1	−1	+2	+2	+2	+2	0	+3	−1	−1	−1	−2	−2	−3	−3	−3	−1	−1
14	0	+1	0	−1	+1	+1	+2	+1	+2	+3	+2	+2	0	+2	−2	−2	−2	−1	−3	−3	−2	−3	−2	−1
15	+1	+1	0	−1	+2	+2	+2	+3	+3	+3	+2	0	0	0	−1	−2	−1	−1	−3	−3	−3	−3	−1	−2
16	+1	+1	+1	0	+1	+2	+2	+2	+2	+3	+2	0	0	−1	−1	−2	−2	−2	−2	−3	−3	−3	−2	−2
17	+2	+1	0	+1	+1	+1	+2	+2	+3	+3	+1	0	0	−2	−1	−2	−2	−2	−3	−2	−2	−3	−2	−2
18	+1	+1	+1	+1	+1	+1	+2	+3	+2	+3	+2	+1	−1	−3	−1	−1	−2	−2	−2	−2	−1	−3	−2	−2
19	+2	+2	+1	+2	+1	+1	+2	+4	+3	+4	+2	+1	0	−3	−1	−1	−2	−3	−3	−3	−2	−2	−2	−2
20	+1	+1	+2	+2	+1	0	+2	+3	+2	+2	+3	+3	−1	−2	−1	−1	−2	−2	−2	−2	−1	−2	−3	−3
21	+2	+2	+1	+1	+1	+1	+2	+3	+2	+3	+2	+4	0	+1	−1	−1	−2	−2	−3	−2	−1	−2	−2	−3
22	+2	+2	+2	+2	+1	−1	+2	+2	+2	+3	+2	+4	0	0	−1	0	−2	−3	−3	−2	−1	−2	−3	−3
23	+1	+3	+1	+2	+1	0	+2	+2	+3	+2	+2	+4	0	+1	−2	−1	−2	−3	−3	−2	−1	−1	−2	−4
24	+2	+2	+1	+2	+1	0	+2	+2	+2	+3	+1	+5	0	+1	−1	−1	−2	−2	−2	−3	0	−1	−2	−3
25	+1	+2	+1	+2	+2	+1	+2	+1	+2	+3	+2	+4	+1	+1	−1	0	−2	−2	−3	−3	0	−1	−3	−2
26	0	+2	+1	+2	+2	+2	+3	+2	+2	+3	+2	+1	0	+1	−1	−2	−1	−2	−3	−3	0	0	−2	−2
27	+1	+1	+1	+1	+2	+4	+3	+2	+3	+2	+1	−1	+1	+1	−2	−2	−2	−2	−2	−3	+1	+2	−1	−1
28	0	0	+1	+2	+2	+3	+3	+3	+2	+3	+1	−1	+1	+2	−1	−2	−2	−2	−2	−3	+1	+2	−1	−1
29	+1	−1	……		+3	+4	+3	+4	+2	+3	+1	−1	0	+1	−2	−2	−1	−1	−2	−2	0	+3	−2	+1
30	+1	−2	……		+2	+4	+3	+5	+3	+3	0	−3	+1	+1	−2	−3	−2	−1	−2	−2	+1	+3	−1	+1
31	0	−2	……		+2	+4	……		+2	+3	……		0	0	−2	−2	……		−2	−1	……		−1	+1

Table II. Temperature for each Day at Greenwich.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	36·97	38·21	39·91	44·22	49·74	56·44	61·35	62·21	59·07	53·93	46·36	41·81
2	36·81	38·24	39·99	44·42	50·05	56·64	61·39	62·22	58·87	53·74	46·18	41·80
3	36·67	38·29	40·05	44·59	50·32	56·82	61·45	62·22	58·67	53·55	45·99	41·78
4	36·56	38·35	40·10	44·75	50·58	56·99	61·52	62·21	58·47	53·33	45·78	41·74
5	36·44	38·41	40·17	44·87	50·80	57·15	61·58	62·17	58·27	53·10	45·57	41·68
6	36·33	38·46	40·26	44·98	50·98	57·32	61·63	62·12	58·12	52·85	45·32	41·57
7	36·23	38·50	40·37	45·06	51·15	57·50	61·67	62·08	57·97	52·60	45·02	41·44
8	36·15	38·50	40·49	45·12	51·29	57·68	61·72	62·03	57·84	52·33	44·71	41·27
9	36·10	38·48	40·61	45·17	51·41	57·85	61·80	61·98	57·72	52·04	44·38	41·09
10	36·10	38·46	40·75	45·23	51·54	58·01	61·88	61·93	57·59	51·78	44·08	40·92
11	36·13	38·44	40·91	45·31	51·69	58·18	61·96	61·86	57·46	51·51	43·78	40·76
12	36·19	38·41	41·08	45·42	51·85	58·35	62·01	61·77	57·31	51·22	43·50	40·63
13	36·26	38·40	41·26	45·55	52·02	58·53	62·03	61·66	57·17	50·95	43·23	40·49
14	36·32	38·42	41·42	45·72	52·22	58·72	62·03	61·54	57·03	50·69	42·96	40·34
15	36·42	38·44	41·57	45·89	52·46	58·89	62·02	61·43	56·87	50·43	42·69	40·17
16	36·53	38·48	41·69	46·06	52·72	59·06	61·99	61·32	56·71	50·18	42·45	40·00
17	36·68	38·54	41·79	46·25	52·97	59·23	61·97	61·21	56·52	49·92	42·24	39·80
18	36·84	38·63	41·89	46·46	53·21	59·42	61·93	61·09	56·31	49·67	42·06	39·60
19	36·99	38·75	42·00	46·67	53·46	59·63	61·88	60·98	56·09	49·44	41·90	39·36
20	37·14	38·87	42·11	46·89	53·69	59·85	61·84	60·87	55·88	49·16	41·77	39·11
21	37·30	39·02	42·20	47·10	53·92	60·07	61·80	60·76	55·67	48·88	41·67	38·87
22	37·47	39·17	42·30	47·31	54·14	60·27	61·79	60·65	55·48	48·61	41·58	38·62
23	37·61	39·31	42·41	47·52	54·38	60·47	61·80	60·54	55·30	48·33	41·51	38·39
24	37·75	39·42	42·54	47·72	54·61	60·64	61·82	60·43	55·12	48·05	41·47	38·16
25	37·86	39·53	42·69	47·94	54·84	60·82	61·86	60·32	54·94	47·78	41·47	37·94
26	37·94	39·63	42·88	48·20	55·05	60·98	61·93	60·18	54·76	47·52	41·52	37·75
27	38·00	39·73	43·11	48·47	55·28	61·13	62·00	60·03	54·58	47·29	41·57	37·59
28	38·05	39·83	43·34	48·78	55·52	61·24	62·07	59·86	54·43	47·09	41·65	37·45
29	38·10	......	43·57	49·10	55·75	61·30	62·12	59·67	54·27	46·89	41·73	37·34
30	38·15	......	43·80	49·42	55·98	61·33	62·17	59·47	54·10	46·72	41·78	37·24
31	38·18	......	44·01	......	56·22	......	62·19	59·27	......	46·54	......	37·11

SUNDRY NOTES.

Barometer-Scales.

In the course of an examination into certain apparent anomalies presented by a comparison of observations with the English and metrical scales, I have discovered that a serious error exists in barometers furnished with both scales as *usually* constructed in this country. The same results have been simultaneously and independently arrived at by Mr. W. Mathews of Birmingham; and that gentleman has already communicated them to the 'Philosophical Magazine' and to the 'Alpine Journal' for December; but I venture to think that the subject is of sufficient importance to meteorologists and travellers to render still wider publicity desirable.

It appears to be the ordinary practice of instrument-makers, when constructing a barometer with the English and French scales, to turn to the tables for the conversion of inches into millimètres, or *vice versâ*, and assume that the equivalents there found are to be implicitly adopted. I am far from blaming them for this assumption, but merely wish to show that it must in future cease to be acted on. An examination into the data on which these tables are constructed shows that they merely profess to give the equivalent of English inches *at the standard temperature of the yard* (62° F.), in millimètres *at the standard temperature of the mètre* (0° C. or 32° F.). Hence the reading of the metrical scale of a barometer corresponding to any given number of inches should be the tabular equivalent *less a correction for the expansion of the scale between the respective standard temperatures* (0° C. *and* 62° F.), *or through a range of* 30° F. (16°·67 C.).

It will be at once apparent that, at the same pressure, the amount of this correction will be constant, whatever be the temperature *common to the two scales.*

An example will render my meaning clearer.

Let the barometer-reading on the English scale be 31 inches, the equivalent of which in the tables is 787·39 millimètres, based on the assumption that the temperatures of the scales are respectively 62° and 32° F. If the attached thermometer indicate 62°, it is clear that the requisite condition is not realized in the case of the metrical scale, which must therefore be corrected.

Let A be the linear expansion of brass for 1° C. $=\cdot000018782$, B the metrical reading$=787\cdot39$ mm., and t the temperature$=62°$ F. or 16°·67 C. Then $AB\times t=\cdot000018782\times787\cdot39\times16\cdot67=0\cdot247$ mm. will be the amount to be deducted from the reading of the metrical scale equivalent to 31 inches, as given in the table, in order to bring it to the same temperature as the English one.

Unless this be done, a discrepancy must always become apparent in the reduced readings of the two scales. For instance, in the case of a mountain barometer by one of our leading makers now in my possession, I find 761·99 millimètres are made to correspond (following the authority of the tables) to 30 inches. If the temperature of the attached thermometer be 62° F., the respective readings reduced to the freezing-point become 30−0·090= 29·910 inches at the standard temperature (62° F.), 761·99−2·05 =759·94 millimètres at the standard temperature 0° C. (32° F.).

Turning to the tables for the comparison of the scales, we find that 29·910 inches at 62° F. are equivalent to 759·70 millimètres at 0° C., instead of 759·94 as above. If the barometer were properly constructed, we ought to have read 761·75 millimètres as corresponding to 30 inches, and the figures reduced to the freezing-point would be 30−0·090=29·910 standard inches, 761·75−2·05=759·70 standard millimètres,—a result which corresponds with the figures of the tables.

For practical purposes the case may be briefly put as follows:—

At the respective *standard temperatures* 1 inch=25·39954 mm., or 25·4 mm. nearly. At 62° F., and therefore at every other temperature common to the two scales, 1 inch=25·4 mm. $(1-30a)$ where a is the coefficient of dilatation of brass for 1° F.= ·0000104344.

1 inch=25·4−·008 mm.
=25·392 mm.

Therefore, at the *standard temperatures*,

30 inches= 25·4 mm. × 30
=762 mm., as in the tables.

At a *common temperature*,

30 inches=762·0−·008 mm. × 30
=762·0−·240 mm.
=761·760 mm.

In practice this is sufficiently near the mark; but if greater accuracy be required, the following figures may be adopted as the respective equivalents of an inch and a millimètre at all *common temperatures*:—

1 inch =25·3916 millimètres.
1 millimètre= 0·0393831 inch.

The following Tables are constructed on this basis:—

TABLE I.

Inches.		Millimètres.	Inches.		Millimètres.
32	=	812·5312	10	=	253·9160
31	=	787·1396	9	=	228·5244
30	=	761·7480	8	=	203·1328
29	=	736·3564	7	=	177·7412
28	=	710·9648	6	=	152·3496
27	=	685·5732	5	=	126·9580
26	=	660·1816	4	=	101·5664
25	=	634·7900	3	=	76·1748
20	=	507·8320	2	=	50·7832
15	=	380·8740	1	=	25·3916

TABLE II.

Millimètres.		Inches.	Millimètres.		Inches.
800	=	31·50648	40	=	1·575324
700	=	27·56817	30	=	1·181493
600	=	23·62986	20	=	0·787662
500	=	19·69155	10	=	0·393831
400	=	15·75324	9	=	0·3544479
300	=	11·81493	8	=	0·3150648
200	=	7·87662	7	=	0·2756817
100	=	3·93831	6	=	0·2362986
90	=	3·544479	5	=	0·1969155
80	=	3·150648	4	=	0·1575324
70	=	2·756817	3	=	0·1181493
60	=	2·362986	2	=	0·0787662
50	=	1·969155	1	=	0·0393831

In conclusion, I would not be taken to assert that all our English double-scale barometers are defective in the point in question; but I believe that the mistake is very general, and that in many first-class standard instruments, furnished with the metrical as well as the English scales, it has not been avoided.

The Tables to which I have throughout referred are those published by the Smithsonian Institution, Washington, amongst their "Miscellaneous Collections," and under the able editorship of Professor A. Guyot; second edition, Washington, 1858.—F. F. TUCKETT, *in the 'Reader,' Dec.* 10, 1864.

To J. Glaisher, Esq., F.R.S.

Royal Observatory, Greenwich,
London, S.E., 1865, October 13.

MY DEAR SIR,—Being in the Trafalgar Road, East Greenwich, yesterday evening, your son and I observed, at 7^h 27^m a brilliant meteor, which we agreed at least equalled the planet Jupiter in brightness. I saw it first at a point about 5° to the east of *α* Ursæ Majoris, whence its course was visible for about 20°, when it disappeared 2° or 3° north of Capella. The time of visibility was from 2 to 3 seconds. Mr. J. L. W. Glaisher thought the colour was greenish. Neither of us remarked anything of a train or sparks. It will be noticed that the meteor was very low in the heavens. But, being so early in the evening, it is likely that it was also seen by other persons.—W. T. LYNN.

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SESSION 1865–66,

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C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Lieut. Edmund Hope Verney, R.N., of Claydon House, Bucks, was balloted for and duly elected a Member of the Society.

The names of Three Candidates for admission into the Society were read.

CX. *Translation of some Remarks by Professor Wolf on Professor Lamont's Paper on the Ten-year Period of the Magnetic Variation and of the Solar Spots.* By W. T. Lynn, Esq., B.A.

Herr Lamont, after communicating the valuable series that have been obtained for the magnetic declination variation in Petersburg, Katherinenburg, Nertschinsk, and Barnaul (series which I received a short time since in still greater extent through the kindness of Herr Kupffer, and purpose shortly to exhibit in the former manner by formulæ), and collecting them for comparison with the known series of Munich, Hobarton, Torōnto, and St. Helena, continues, "The turning-points determined with certainty are now as follows:—

Maxima: 1786·5; 1817·0; 1829·0; 1837·5; 1848·8; 1859·5.
Minima: 1823·3; 1843·0; 1855·0.

And if we assume the length of the period to be, as I have determined it, 10·43 years, and start from 1786·5 as initial point, we shall have the following residual errors:—

Maxima: 0·0, +0·4, +1·6, +1·1, −0·3, 0·0.
Minima: −0·3, +0·8, −0·7.

"Herr Wolf has, in Poggendorff's 'Annals' (for May 1863), repeatedly asserted that the period should be assumed at 11·11 years, which would leave the following residual errors:—

Maxima: 0·0, +2·8, +1·9, +4·5, −4·4, −4·8.
Minima: −2·0, −4·6, −3·7.

"It is evident that it is quite impossible to satisfy the observations by a period of 11·11 years; and this is also the conclusion to which the careful investigation of Mr. Sabine (Magnetical and Meteorological Observations at St. Helena, vol. ii. p. 126) has conducted him."

Now, without mentioning some small errors of calculation in the formation of the above series of errors, and passing over also the quotation from Sabine, which appears to me irrelevant to the point in question, I must claim permission to make some remarks upon this passage. In the first place, I must still maintain the accuracy of the epochs established by me, partly in my communications, partly in Poggendorff's 'Annals:'

Maxima: 1787·2; 1817·5; 1829·7; 1837·7; 1848·9; 1860·0.
Minima: 1823·8; 1844·2; 1856·3,

whilst I cannot understand what right Herr Lamont has to transform them in that manner: for example, I do not see how it can be inferred from the very regular run of the existing variation-series,

	1854.	1855.	1856.	1857.	1858.
Munich	7·56	7·33	7·08	7·64	9·33
Prague	6·81	6·41	5·98	6·95	7·41
Christiana ...	6·00	5·16	5·02	5·50	7·55
Petersburg ...	6·55	6·15	5·50	6·19	

that the minimum placed by me at 1856·3 can be arbitrarily transferred to 1855·0, or to the mid-time between 1854 and 1855, and similarly in other cases. In the second place, it is undoubtedly correct that I maintained (which I must still continue to do) the same mean period of 11·11 years for the magnetic variation as that obtained for the solar spots; but as Herr Lamont, who expresses himself as if he had read my publications with very especial attention, should well know, not because individual differences, referred to a connected series of epochs like the above, become smaller than for a period of somewhat different length, but principally for this reason, that in regard both to solar spots and magnetic variations, as the established times for the former,

Maxima: 1788·5; 1816·8; 1829·5; 1837·2; 1848·6; 1860·2.
Minima: 1823·2; 1844·0; 1856·2,

compared with the above variation-epochs, satisfactorily show, the true epochs vary in the same manner with reference to the mean epochs. Had Herr Lamont, as he should have done, taken the differences between the mutually corresponding epochs, he would have found for the

Maxima: −1·3; 0·7; 0·2; 0·5; 0·3; −0·2.
Minima: 0·6; 0·2; 0·1;

and these differences, which may be considered as evanescent when referred to the limits of error fixed by me, would then have well borne comparison with his. This may, however, pass; but when Herr Lamont continues, "With the view of proving that the magnetic period of 10·43 years is inadmissible, Herr Wolf relies upon this, that, according to the London observations, a minimum took place in the year 1796, whereas, if that period was correct, a maximum should then have occurred. Now Gilpin's observations give the following numbers for the 11 years from 1795 to 1805:—

7′·6, 8′·0, 7′·9, 7′·6, 7′·3, 7′·1, 8′·0, 8′·2, 8′·2, 9′·2, 8′·5, 8′·6.

How, from these numbers, a maximum* could be perceived in the year 1796 I cannot, for my own part, imagine; they show, in fact, no period at all, which is quite intelligible if we reflect that a needle placed upon a point was employed, the sensitiveness of which was so small that, according to Gilpin's express declaration, the casual deviations might amount to from 8 to 10 minutes, or even more."

I must decidedly object to such a conclusion being drawn from my notice in Poggendorff; for I said there, in reference to a Table including the years 1749–1860, in which I had communicated for 1786–1788 the Paris variations

---

* He should have said a minimum.

14·0, 15·1, 13·5,

and for 1789–1805 the London variations

12·6? 14·8? 12·3? 8·9? 8·4 8·3? 7·5? 8·0? 8·3? 7·4?
7·6? 7·1? 7·7? 8·6? 9·2? 8·5? 8·7?,

that the real point in dispute between Herr Lamont and myself consisted in this, that he assumed between 1786 and 1860 seven periods of nearly equal length, whilst I must insist upon it that during that time only six periods had elapsed of sensibly different lengths, and then continued, "There are in the solar spots, as my Table shows, according to the observations of Staudacher, Flaugergues, &c., certainly only six periods, and the magnetic variations, so far as they are known, agree quite clearly therewith. But if, with Herr Lamont, seven periods be assumed, we have to fix a magnetic minimum at 1791·3, and a maximum at 1796·5, which would be in complete contradiction with the London observations, and also totally opposed to the parallelism, in other respects so clearly expressed, with the solar spots." Now why should Herr Lamont, if he wished to contest my view in good faith, not only have passed over the principal point, but omitted from the years 1789–1794 the first half of the London observations, which connect themselves quite distinctly with the Paris variations, and not have spoken at all of his untenable minimum of 1791? He has therefore placed himself upon ground on which anything like friendly discussion becomes impossible, and on which I must decline to follow him further. I confine myself therefore now, in conclusion, to pointing out that Herr Lamont, in the sequel of his paper, criticises the epochs established by me from the observations of Staudacher, Zucconi, Flaugergues, &c., of the more ancient solar-spot maxima and minima, in a manner which it would not be difficult to refute, and pretends to have found in Schwabe's series of observations the regular periodicity of the solar spots expressed in the most determinate manner. As the latter series gives the

Maxima.		Minima.	
1828		1833	
	9		10
1837		1843	
	11		13
1848		1856	
	12	Mean	11·5
1860			
Mean	10·7		

and therefore in the mean of these means again only the worthless period 11·1, and assigns periods which disagree with the mean period to the amount of two years, it would have appeared to me more consistent if Herr Lamont had rejected it also, instead of desiring by its means to contest my consistent results, and to save his period of 10·4 years. I myself of course can only rejoice that I succeeded, even in 1852, with the help of the records of observers who "had neither a determinate method in view, nor proposed to themselves a definite purpose, nor were possessed of sufficient optical assistance," in obtaining results which have been continually confirmed as well by the old observations hitherto found, and the new more recently instituted, as by the discovery of the parallelism, evident to everyone, in the frequency of solar spots and auroræ; and this pleasure may comfort me for the courtesy to me with which Herr Lamont says, "It may easily be foreseen that Herr Wolf, in spite of vehement assertion, and confident and oft-repeated publication of his results, will meet with but trifling success. Of the few writers who mention the 'eleven-year' period of solar spots, certainly not one has read his publications with attention," —particularly as amongst these *few* writers appear the names of Herschel, Carrington, Gautier, Littrow, Winnecke, Secchi, Hansteen, Buys-Ballot, Hirsch, &c., who will doubtless find an opportunity of thanking Herr Lamont personally for his compliment; and the venerable Schwabe has written to me quite lately:— "Although I am only an amateur, and neither mathematician nor astronomer by profession, I am nevertheless convinced that you are pursuing the only right way to establish the period of the solar spots, and that you in your labours, and this with me has especial weight, keep yourself free from prepossession and without preconceived opinions;" he has moreover very recently stated, in the 'Astronomische Nachrichten,' that he regards my period of 11¼ years as a rectification of his provisional period of 10 years.

CXI. *Description of a New Anemometer for Self-registering the Pressure, Velocity, and Direction of the Wind.* By C. O. F. Cator, Esq., M.A.

The object of this instrument is to obtain, by the wind acting on *one* surface only, a daily register of its pressure in pounds on an area of a square foot, and the total daily horizontal motion of the air in twenty-four hours, or any other given time, and thence its hourly velocity.

The surface upon which the wind acts, or the "pressure-plate," is the base of a cone, whose axis is horizontal, and the area of the base equal to one square foot, the object of the cone at the back of the pressure-plate being that there shall be as little resistance as possible to the plate being pressed through the air by the wind, and to neutralize the effect of a vacuum being formed behind it. The plate is kept opposite and at right angles to the direction of the wind by a vane, and by means of this the direction of the wind is also registered*.

The plate is attached to the end of a horizontal bar, and, with it, is moved to and fro, the bar working on friction-rollers, and resting on two strong supporting arms.

These are the only parts of the instrument which are out-of-doors or exposed to the weather. A short length of chain is attached to about the centre of the horizontal bar between the two supporting arms; it passes over a pulley, and is then fastened to a cord which goes down through a vertical tube, as a connexion with the rest of the instrument, the whole of which is below, inside the building on which the anemometer is fixed, and therefore effectually protected from the weather.

Pressure.—We now come to those parts within the building which are designed immediately to measure the pressure, mean pressure, and velocity. And first in respect to *pressure*. The *pressure* of the wind is measured by means of two curved levers of equal length acting against one another, their motion being in a vertical plane, and their curved edges rolling one against the other; at one end of the upper lever is fastened a fixed weight, and to the opposite end of the under one is attached the abovementioned cord at the lower extremity of the vertical tube; the other ends respectively of the two levers work on pivots, and round these they revolve through a small angle, when set in motion by the wind. When there is a calm, their point of contact is at the fixed weight, and so in this case the length of arm from the fulcrum to the point where the wind-force or the cord is applied, is the whole length of the lever, and the length of arm at the weight end is zero, because the weight is *at* the fulcrum, and therefore a very small pressure of wind on the pressure-plate, or, which is the same thing, a very small force applied at the cord-end of the under lever, will move that end of it through an appreciable space; and it will be seen that as the wind presses with more and more force aginst the plate, it causes the cord to lift up the levers through a greater and greater space, and their point of contact to move more and more towards the cord or power-end, and so the length of arm at the power-end becomes shorter, as that at the weight-end becomes longer, and of course requiring so much greater pressure of wind applied at the pressure-plate, or, which is the same thing, requiring so much greater force applied at the cord-end of the under lever, to lift it further up; and in every case, when the wind subsides, the levers return of their own accord to the zero-point, or their original position. To the cord-end of the under lever is also attached a line, which is made to carry a pencil to and fro along a cylinder in the direction of its axis, as the levers are moved up and down. This cylinder is made to revolve round its axis at a regular rate by a driving-clock once in twenty-four hours, and therefore the pencil will trace on a paper rolled round the cylinder, a curve of the pressure of the wind for the twenty-four hours.

---

* For this purpose a couple of fans can be applied, if required or thought preferable, to the vane, or one substituted for the other at pleasure.

Mean Pressure and Velocity.—We now come to *mean pressure* and *velocity*, or the daily horizontal motion of the air in miles, which must be considered at one and the same time. These results are designed to be shown by a clock, which, to distinguish it from the cylinder-driving-clock, is called the "gaining-clock." Another line is also attached to the same end of the under lever as the line which is made to carry the pencil, and, after passing round a pulley and a spiral, passes into the "gaining-clock," and is connected with its regulator; and it is so arranged that as the wind blows more or less strongly, this line draws the regulator so much more or less towards the "fast" end, and so alters the rate of gaining of this clock; there is a little weight as a counterpoise which draws the regulator back towards the "slow" end, as the wind abates. This clock is made with the regulator having so large a range that it will gain as much as what in an ordinary clock would be nearly two hours (or in this case nearly two revolutions of the long hand) in twenty-four hours, if the regulator were to remain at the extreme "fast" end during that time; and it will go at a regular rate and true time, if and whenever the regulator is at the extreme "slow" end: and the instrument is so arranged that, whenever there is a calm, the regulator is at the "slow" end, and therefore the clock will go true time, and as the wind blows more or less, the clock gains more or less. The face of this clock is graduated into divisions on two circles; those on the inner one representing mean pressure in pounds, and those on the outer one, miles or velocity. So, if the hands are set at what would be "12" in any ordinary clock, or in this case at zero, at a fixed time every day, say at 9 A.M., then, supposing it to have been a perfect calm for the next twenty-four hours, the long-hand will, by 9 A.M. next day, have made just twenty-four revolutions and no more, or it will be found at the zero, which will of course show a mean pressure of 0·0 lb., and the horizontal motion will also be 0, *i. e.* zero; this, however, rarely if ever occurs; and supposing there to have been wind, then, wherever the long hand (besides having made twenty-four revolutions) is found at the end of twenty-four hours, or at 9 A.M. next day, there will be found on the inner circle the figures representing the *exact* mean pressure for those twenty-four hours, and on the outer circle the figures representing the total horizontal motion of the air in miles. For example, if we find at the end of twenty-four hours that the long hand, besides making twenty-four revolutions, has reached a point on the inner circle marked "0·12," it will show that the wind has during that time blown with a mean pressure of 0·12 lb.; and we find that the point reached on the outer circle is marked 120, that will show that the horizontal motion of the air in the same time has been 120 miles, or that there has been an average hourly velocity of five miles. [It is evident that this clock is of no use as a time-piece, when attached to the anemometer.]

Direction.—We now come to the subject of the *direction of the wind.* The curve of the *direction* of the wind is obtained by a pencil, in the form of a thread, round a small revolving drum, which is connected with the above-mentioned vertical tube, which always revolves with the wind as its direction changes, as in the anemometer now in use at the Kew Observatory. This curve is traced on the same paper as the pressure-curve, the straight lines representing the hours of the day answering for both curves.

Advantages.—It remains to consider the peculiar advantages of this instrument. The *advantages* which this instrument has over other anemometers *in general* now in use, are the combination of pressure and velocity, the wind acting on *one* surface only; and over other *pressure*-anemometers, that the only parts out-of-doors and exposed to the weather are the pressure-plate and vane, all the rest of the instrument comprising all the working apparatus, and the levers, which are the resistance to the force of the wind, being inside the building, and protected from the weather; whereas the springs which are the resistance to the force of the wind in other pressure-instruments are out-of-doors behind the pressure-plate, and therefore very much exposed to the action of the weather, liable to rust, &c.; now a lever is preferable to springs for this purpose in *any* position, because springs cannot keep their original strength for ever, but must get weaker from age and constant use, and besides are liable to be too stiff from rust and accumulated dust and dirt; and springs indoors are preferable to springs out-of-doors, therefore, *a fortiori*, a lever indoors is preferable to springs out-of-doors. We now come to one of the peculiar features of this instrument, in that, while it is capable of the greatest susceptibility, it also exhibits, without being impaired, the greatest pressure of wind that has yet been brought to bear upon it. A pressure of wind of only $\frac{1}{10}$th of a pound will cause the pencil to move through an appreciable space (*i. e.* about $\frac{1}{20}$th of an inch), while at the same time the instrument will bear a pressure of even 56 lbs. or more if required, and the pencil will show it, the whole scale being comprised in a space of 5¾ inches; a large portion of the scale being devoted to the lower pressures, *i. e.* about 1 inch to the first 2 lbs., which allows space enough for small fractions of a pound to be measured, and the spaces gradually diminishing for each pound as the numbers rise, where indications of integral pounds only are wanted, and fractions not required; whereas springs, which are strong enough to bear a pressure of 20 or 30 lbs., will not show any pressures generally under ½ lb. In some instruments the spaces allotted throughout the scale are nearly equal for high and low numbers, which makes it impossible to record the small pressures, even if the instrument were sensitive enough otherwise to indicate it. Again, strong gusts of wind will be plainly indicated by this and other pressure-instruments, but are hardly discernible in the velocity-curve of a cup-anemometer. Again, a pressure-plate, with a conical back to it, is preferable to one without it, as it will be more easily moved through the air with a very slight pressure of wind, as, being pointed, it will cut through the air more easily than the ordinary plate, which, having a flat surface, must take a greater pressure to do so; and the consequence is that in very light pressures the ordinary plate will either not be moved at all, or will not be pushed through far enough, and therefore the pencil will show either no pressure at all or too small a pressure. And when we come to strong winds, a plate with a conical back to it is not subject (or at any rate it is much less subject) to the errors arising from, and false results given by, a partial vacuum being created behind the plate by gusts, which would be so in the case of a plate without a conical back; for when a strong gust comes, a partial vacuum is created behind the plate, and the consequence is that the plate is pushed through too far, and therefore too great a pressure is shown by the pencil. The error arising from this must, it should seem, be considerable. Again, the "gaining-clock," independently of the velocity, is designed to show the *exact* mean pressure, or the mean of an *infinite* number of observations, instead of only an *adopted* mean pressure, or the mean of twenty-four or any other certain or *finite* number of observations, as in other pressure-anemometers. In addition to the above advantages, the combination in this instrument of pressure and velocity dispenses with the necessity of using, at the time of making observations, a book of tables for their conversion; for the "gaining-clock" itself gives the results of the calculations which would have to be made for converting pressure into velocity.

In conclusion, it may be interesting to know that the instrument was put up in Bryanston Square in the beginning of September last, and was working there under my own eye till the middle of December; and during that period it was not until the third week in October that there was wind of any note to try it, but still it registered what little wind there was, many times when the anemometer at Greenwich showed no pressures at all; for from September 8–30 this instrument registered pressures on fifteen days, while in the same time the one at Greenwich showed pressures only on two days. Again, in October this instrument showed pressures on twenty-seven days, while the one at Greenwich did so only on fifteen days. In November, when there was much more wind, the instrument worked remarkably well. Up to the 18th of November, the pressure-plate was kept opposite to the direction of the wind by a couple of fans; but Mr. Glaisher a short time previously remarked to me that on windy days this instrument did not seem to have registered so high a pressure as it should have done, on account of the fans not allowing the plate to turn round so quickly as the direction of the wind changed, and therefore, if a gust should come at that moment, the plate not being at right angles to the direction of the wind, the pencil would not record a pressure high enough; for instance, on October 25th, 6 lbs. was the maximum pressure on the square foot by this instrument, the Greenwich anemometer showing a maximum of 20 lbs.; and on this occasion Mr. Glaisher was so good as to suggest a remedy of the substitution of a vane instead of the fans; therefore by the kind advice of that gentleman and Mr. Symons, the vane was adopted; and on the 18th of November it came into operation, since which time it appears to have worked decidedly better than before; for the pressure-plate has certainly veered much more frequently to and fro with the wind, and therefore we may presume that the plate has been kept very much more nearly, if not as nearly as possible, opposite to the direction of the wind at every gust.

It was stated above that the instrument was at work till the middle of December, since which time, owing to my unavoidable absence from home, and there being no one who was competent to attend to it regularly, it has not been working, and consequently we have not had any records from it of these late frequent high winds; however, it is hoped that the instrument will soon be set to work again, not in Bryanston Square, but at the Royal Observatory, Greenwich, where it will have the advantage of being under Mr. Glaisher's own superintendence.

CXII. *The November Showers of Meteors in* 1865.

By James Glaisher, Esq., F.R.S., Secretary.

The periodical shooting showers of August and November are those which usually attract the most attention, and naturally that of November, from the circumstance of the displays of star-showers having been found to be more numerous than any other at this time.

From the observations which have been made of those displays in different years, the length of the annual and other periods have been approximately determined, and this year the time calculated for the great display was in the hour following midnight of Sunday the 12th.

At the Royal Observatory, Greenwich, arrangements were made for observations throughout the night. From 6^h P.M., on the 12th, till 8^h the sky was cloudless, and two meteors only were seen; from 8^h to midnight the sky was cloudy, and no meteors were consequently observed; soon after midnight there were small breaks in the clouds, increasing in extent till the sky was cloudless at 20 minutes before 1^h A.M. on the 13th, and then continued for the most part cloudless throughout the remainder of the morning. The observers were Messrs. Nash, Harding, F. Trapaud, E. Jones, Wright, and Lieut. Rikatcheff, R.I.N. By 1^h A.M., 29 meteors were observed. Between the hours of 1^h and 2^h there were 90; in the next hour, 66; between 3^h and 4^h there were 49; and by 5^h A.M., 43 additional meteors were noted, making in all 279 whose paths, colours, and other particulars were recorded.

Between $4^h 45^m$ and $4^h 57^m$, the paths, colours, and sizes were not recorded; but all the meteors which were visible in the W. and S.W. quarters of the heavens were counted to the number of 25; and meteors were quite as numerous in the E. and N.E. portions of the sky as in the W. and S.W. Therefore at this time meteors were appearing fully at the rate of 250 per hour, and these were for the most part of the first class; there were additional smaller meteors, but less numerous. It is calculated that for every meteor recorded, that at least two additional passed without their positions being registered.

At 5^h the moon was shining brightly, still very many meteors were seen till half-past 5; some of them were situated very near the moon.

TABLE I. Number of differently-coloured Meteors observed at the Royal Observatory, Greenwich, on 1865, November 13, from 0^h to 5^h A.M.

Colours of Meteors.	Number of Meteors referred to different colours.					
	0^h to 1^h A.M.	1^h to 2^h A.M.	2^h to 3^h A.M.	3^h to 4^h A.M.	4^h to 5^h A.M.	Totals, 0^h to 5^h A.M.
Blue	10	60	55	41	31	197
White.....................	6	13	7	3	5	34
Bluish white	3	14	4	3	6	30
Yellow	3	1	......	......	......	4
Red.......................	1	2	......	......	1	4
Rose	......	1	......	......	......	1
Green	......	......	......	1	......	1
Total number per hour of all colours	23	91	66	48	43	271
Percentage of Blue Meteors, each hour	43·5	65·9	83·3	85·4	72·1	72·69

TABLE II. Number of Meteors referred to different Magnitudes, observed at the Royal Observatory, Greenwich, on 1865, November 13, from 0ʰ to 5ʰ A.M.

Sizes of Meteors.	Number of Meteors referred to different magnitudes.					
	0ʰ to 1ʰ A.M.	1ʰ to 2ʰ A.M.	2ʰ to 3ʰ A.M.	3ʰ to 4ʰ A.M.	4ʰ to 5ʰ A.M.	Totals, 0ʰ to 5ʰ A.M.
= Jupiter	1	1	1	......	1	4
Twice as great as, or brighter and larger than Sirius.........	......	1	1	......	......	2
= Sirius..................	......	4	6	3	1	14
= Procyon	......	1	......	......	......	1
= greater than 1st mag. *	1	6	2	......	1	10
= 1st mag. *............	6	33	26	32	30	127
= 2nd mag. *	9	29	23	9	6	76
= 3rd mag. *	5	13	6	4	3	31
= 4th mag. *...	1	2	1	......	1	5
= 5th mag. *	......	1	......	......	......	1
Total number per hour	23	91	66	48	43	271
Number = 1st mag. * and greater than 1st mag. *	8	46	36	35	33	158
Percentage of 1st class meteors for each hour	34·78	50·55	54·55	72·92	76·75	58·30

TABLE III. Percentages of Meteors of each Class (1st magnitude, 2nd magnitude, and less than 2nd magnitude) during each hour, as deduced from observations at the Royal Observatory, Greenwich, on 1865, November 13.

Hours of Observation.	Percentages of Meteors in each Hour, of each Class.		
	Equal to, or greater than a 1st mag. *.	Equal to a 2nd mag. *.	Less than 2nd mag. *.
0ʰ to 1ʰ A.M.	34·78	39·13	26·09
1ʰ to 2ʰ A.M.	50·55	31·87	17·58
2ʰ to 3ʰ A.M.	54·55	34·85	10·60
3ʰ to 4ʰ A.M.	72·92	18·75	8·33
4ʰ to 5ʰ A.M.	76·75	13·95	9·30
0ʰ to 5ʰ A.M.	58·30	28·05	13·65

TABLE IV. Showing the Hourly Number of Meteors observed; the Number leaving Trains; the Percentage of Meteors of the 1st Class; and the Percentage of Blue Meteors, as observed at the Royal Observatory, Greenwich, on 1865, November 13.

Hours of Observation.	Total number of Meteors observed.	Number of Meteors leaving trains.	Percentage per hour of 1st class Meteors.	Percentage per hour of Blue Meteors.
0^h to 1^h A.M.	23	16	34·78	43·5
1^h to 2^h A.M.	91	54	50·55	65·9
2^h to 3^h A.M.	66	37	54·55	83·3
3^h to 4^h A.M.	48	38	72·92	85·4
4^h to 5^h A.M.	43	27	76·75	72·1
0^h to 5^h A.M.	271	172	58·30	72·69

On the evening of the 13th day, a watch was kept up at the Observatory, from the hour of 6 P.M. till midnight, with the exception of a short interval between half-past 7 and 8 o'clock, and two meteors only were observed during that time. From the circumstance of a few meteors being visible both before and after the calculated time, it would seem that this epoch is determined with a good deal of precision. The display is the finest ever noticed at the Royal Observatory, Greenwich.

Mr. Alexander Herschel was observing at Hawkhurst till nearly 3^h A.M., and he noted the positions, paths, sizes, colours, &c. of 68 meteors.

Of these, there were 17 accordances between Greenwich and Hawkhurst, between midnight of the 12th and 3^h A.M. of the 13th.

The results deduced from five of these doubly observed meteors are shown in the next paper.

CXIII. *Heights and Velocities of the November Meteors*, 1865.—*Meteors simultaneously observed at Greenwich Observatory and at Hawkhurst*. By A. S. HERSCHEL, Esq., B.A.

THE comparison of the observations at Hawkhurst, in Kent, with those at the Royal Observatory, Greenwich, shows that seventeen meteors, at least, observed at Hawkhurst, are identical with meteors contained in the Greenwich list. Among the coinciding meteors, the paths of three, which appeared, respectively, at Greenwich mean time, 14h 14m 59s, 14h 20m 24s, and 14h 52m 1s, lie in a plane containing the Greenwich and Hawkhurst base-line, and are accordingly indeterminate. The apparent courses of five other meteors, more favourably observed at Greenwich and at Hawkhurst, are given in Table I., which also contains the assumed points upon the apparent line of flight at Greenwich, which correspond to the points of first appearance and disappearance of the coinciding meteors at Hawkhurst. These points are for the most part included between the beginning and end points observed at Greenwich, the length of the visible path at the latter place being generally given longer than the length of path at Hawkhurst.

The distance of Hawkhurst from Greenwich Observatory in a direct line is 37·4 British statute miles, and the inclination of this line to a mean meridian plane between the two places is 35° 10′ E. from S. With this base-line the height, and the velocity of each meteor, contained in Table II. was calculated from Table I. In the last column of the Table, a scale of weights from 1–10 represents the value of each accordance with exclusive reference to the degree of precision in the observations. Giving these weights to the results, the average height at first appearance, from all the heights at first appearance contained in the list, is 61 British statute miles, and the height at disappearance is 47 British statute miles above the surface of the earth. The mean direction of four meteors of the November shower (Nos. 1, 2, 4, 5 of the list) is from apparent right ascension 140° 22′, north declination 13° 18′, near the star ξ in the fore foot of *Leo*. The meteor No. 3 of the list was directed from a different part of the sky, in right ascension 22° 35′, north declination 27° 50′, near *α Trianguli*, belonging to a second, much less intense, but coexisting meteoric shower.

The average length of path of the four November meteors, Nos. 1, 2, 4, 5 of the list, obtained by giving proper weights to the results contained in the Table, is 58 miles; and the average velocity is 64 miles per second. The meteor No. 2 appears to have shot upwards, while two other tracks, Nos. 4 and 5, are examples of extremely high and low flights, with correspondingly great and small velocities and lengths of path. These anomalies are probably only apparent, and proceed from slight errors in the observations, very difficult to avoid, affecting the parallax, and producing considerable errors in the estimation of the distance.

The illuminating power and equivalent weight of the meteoric particles are calculated, and entered in the remaining columns of

TABLE I. Apparent Paths of Five Meteors observed simultaneously at the Royal Observatory, Greenwich, and Hawkhurst, Kent, November 12, 1865.

	Apparent Path at Greenwich.											
	Observed								Assumed			
	Hour, G. M. T., Nov. 12.	Mag. as per stars.	Beginning.		End.		Character of streak. Remarks.	Observer.	Beginning.		End.	
			Azim. W. from S.	Alt.	Azim. W. from S.	Alt.			Azim. W. from S.	Alt.	Azim. W. from S.	Alt.
	h m s		° ′	° ′	° ′	° ′			° ′	° ′	° ′	° ′
1	13 30 54	1	347 35	46 35	14 10	26 15	Train three secs.	M. Rikatcheff...	356 40	41 55	6 10	34 45
2	14 3 38	1+	129 10	48 45	116 35	15 15	Fine wavy train.	A. Harding ...	126 50	44 40	119 55	26 45
3	14 4 48	1+	327 30	50 50	314 30	38 55	Train one sec.	W. C. Nash ...	335 0	55 10	321 20	46 30
4	14 9 27	Sir.	322 50	33 40	344 30	21 0	Fine train 2 secs.	Id.	322 50	33 40	337 20	25 50
5	14 37 10	1	310 50	19 0	319 40	13 50	Left a train.	Id.	314 30	16 55	319 5	14 10

	Apparent Path at Hawkhurst.									
	Observed									
	Hour, G. M. T., Nov. 12.	Mag. as per stars.	Beginning.		End.		Colour.	Duration of flight.	Duration of streak.	Observer.
			Azim. W. from S.	Alt.	Azim. W. from S.	Alt.				
	h m s		° ′	° ′	° ′	° ′		sec.	sec.	
1	13 31 0	3	37 25	58 15	54 0	46 20	White	0·7	1	A. S. Herschel.
2	14 3 40	1	135 20	28 25	125 20	21 50	White	1·0	3	Id.
3	14 4 50	2	43 55	82 45	305 45	80 30	Yellow	0·8	none.	Id.
4	14 9 20	1	323 10	38 40	342 10	33 5	White	0·9	3	Id.
5	14 37 0	2	306 25	28 45	314 30	25 20	White	0·7	2	Id.

TABLE II. Real Paths relative to the Earth, calculated from Table I.

	Beginning.				End.				Direction.	
									From	
	Lat. N.	Long.	Height in B. S. miles.	Distance from Hawkhurst in do.	Lat. N.	Long.	Height in B. S. miles.	Distance from Hawkhurst in do.	Apparent R.A.	Apparent N. decl.
	° ′	° ′	miles.	miles.	° ′	° ′	miles.	miles.	° ′	° ′
1	50 40	0 5 E.	49	58	50 44	0 7 W.	35	49	109 55	28 40
2	51 51	0 50 W.	43	91	52 25	2 48 W.	69	184	161 50	28 30
3	51 56	0 23 E.	57	57	51 57	0 38 E.	47	48	22 40	27 50
4	48 56	2 56 E.	147	235	49 33	1 12 E.	68	125	127 20	15 30
5	50 37	1 19 E.	25	51	50 35	1 10 E.	20	46	172 15	40 20

TABLE II. (*continued*).

	Length of path in B. S. miles.	Velocity B. S. miles per second.	Light of meteor at one mile compared to full moon.	Consumption of coal-gas for luminous effect equal to that of meteor.	Mechanical equivalent of the combustion in foot-pounds.	Momentum of one grain weight moving with velocity of meteor.	Weight of meteoric matter arrested, moving with velocity of meteor.	Weight.
		miles per second.	full moon = 1.	cubic feet.	foot-pounds.	foot-pounds.	grains.	
1	17	25	0·01	0·11	56,100	37,200	1·5	6
2	96	96	0·35	5·92	3,100,000	570,700	5·4	5
3	15	18	0·02	0·24	124,400	21,000	6·1	10
4	121	134	0·59	9·12	4,740,000	1,111,000	4·3	4
5	8	12	0·01	0·18	94,010	8,913	10·5	4

the Table, in the same manner as that already described in a list of five meteors observed simultaneously at Cambridge Observatory and at Hawkhurst. The illuminating power, and in consequence, the weight of the meteoric particles, depend for their values directly upon the square of the distance of the meteors. The weight is at the same time inversely proportional, *cæteris paribus*, to the square of the velocity. It follows that considerable errors in the distance and velocity, proceeding from small errors in the parallax, being generally in the same direction, counteract each other, and the weights of the meteoric particles are nearly the same as if no small errors of parallax, of the kind already mentioned, had existed. The average weight of the November meteors contained in the present list, giving proper weights to each observation, is five grains, and this conclusion of the entire calculation, it may be remarked, is a result far less likely to be in error than the separate heights and velocities of the individual meteors.

CXIV. *The November Shower of Meteors.*

By C. G. Prideaux, Esq., F.R.A.S.

I began about 2 A.M., by looking out of my bed-room window with an aspect about S.S.E., and amused myself by looking out of the window, and from my front door with the same aspect, for rather more than half an hour. I can form but a guess of the number of meteors which I saw; but I should say more than twenty, and certainly enough to determine me to go up to the top of Primrose Hill, as it was but about a quarter of a mile off, and the night was then very fine and clear. Two of my household volunteered to go with me, and we strolled slowly up, getting to the top of the hill a few minutes before 3. As we were going up we saw several meteors, I should say about twenty, but I did not count them; when we got to the top I began to count them, my companions giving me notice of every meteor which they saw, and I being very careful not to count the same meteor more than once. We stayed on the hill about 40 minutes, and then strolled slowly back, I still counting the meteors as I saw them and as they were repeated to me: we returned into the house as the neighbouring church clock struck 4. The whole number which I counted, if I recollect right, was 103; it was certainly within a unit or two of that number;

and the whole number which we saw while we were out must have been very nearly, if not quite 120. Some few of the meteors were brilliant, and had brilliant trails; but the majority were not of any great splendour, rather the reverse. It appeared to us that the best position for seeing them was standing with our backs towards the constellation Leo, and in this we were confirmed by other members of my household who were looking out at home. A servant who was looking out from a back window said she thought she must have seen 100; whilst Mrs. Prideaux, who observed from both the back and the front of the house, found the back the better position. I may add that, as I was on my way to the hill, I told a policeman our object; he said he had seen several, and on our return mentioned that he had seen a great many, and especially five in rapid succession just as we were coming up to him. This was all done for the gratification of the moment, rather than with any scientific object. But I think you may fairly assume that we must between us have seen not fewer than 140 in the two hours from 2 A.M. to 4 A.M. Indeed, I feel satisfied myself that 150 would be nearer the mark. At the time we went back into the house the clouds were beginning to gather, but it was beautifully clear the greater part of the time we were out.

SUNDRY NOTES.

To the Editor of the Proceedings of the Meteorological Society.

Mentone, Alpes Maritimes,
January 11, 1866.

SIR,—I trust that the following note of the atmospheric movements attending a very heavy gale from the west and north-west on the 9th and 10th instant may not be without interest.

The gale commenced at about midday of the 9th, and blew with its maximum force from about midnight of the 9th to sunrise of the 10th. It blew, at intervals, with great force during the whole of the 10th, and, with increased violence, at sunset, for about an hour, when it subsided.

The barometer stood at 30·307 inches (corrected for temperature and reduced to the sea-level) at 9 A.M. of the 3rd, and, after slight fluctuations, it stood at 30·107 at 9 A.M. of the 7th. By 9 A.M. of the 8th it had fallen to 29·892, and by 9 A.M. of the 9th to 29·653. It fell during the whole of that day; on one occasion, at sunset, as much as 0·08 in half an hour, until at 11 P.M. it stood at 29·275, and rose to 29·544 by 9 A.M. of the 10th, and continued rising till it reached 29·707 at sunset.

The mean temperature of the first eight days of the month, from observations at 9 A.M. and 9 P.M., had been 49°·8; and the mean humidity of the atmosphere, from observations at the same hours (sat. =100), had been 78. The mean temperature of the 9th and 10th (the days of the gale) was 49°·15, and the mean humidity 64. At midday of the 9th the humidity was 43 only.

On the morning of the 9th, before sunrise, there was a very copious dew, and at sunset on that day some thunder and lightning occurred, and 0·18 in. of rain fell in a few minutes. The night was afterwards clear.

A corresponding violent gale from the same quarter, which burst on the Irish coasts and traversed France, occurred here on the 14th of January in last year.

I am, Sir,
Your most obedient Servant,
D. A. Freeman.

Meteor of January 22, 1865.

A brilliant meteor was seen passing in a south-westerly direction, over the bay, on Monday evening January 22, at about seven minutes before 8 o'clock, Greenwich time. It first appeared in the constellation Taurus, below the Pleiades, about 35° above the horizon, coming from the direction of Orion, towards, but below the moon. Having traversed about 30° in three seconds of time, it burst into fragments, which proceeded in the same direction, becoming dimmer, but not apparently dissolving or leaving more than a faint trace in their path. The colour at first was the bright silvery blue of the magnesium light; after the explosion the fragments were about the colour of Mars. Several persons distinctly heard a report as of a distant gun, variously estimated at from fifteen to forty-five seconds after the meteor burst. If this be correct, it could not have been more than about ten miles distant, and from the direction of the fragments, they must have fallen between Totnes and Plymouth. We shall feel much obliged by any information from observers in other parts of South Devon, especially noting the direction of its path in regard to the moon, and the interval before the explosion was heard.

Edw. Vivian.

Woodfield, Torquay.

British Rainfall.

To the Editor of the Proceedings of the Meteorological Society.

SIR,—I have to ask your readers' attention for a few moments to a request on the above subject, the importance of which in relation to engineering and drainage questions is well known. It is now some years since I began collecting returns of the fall of rain —with what success I will mention presently; but my main difficulty has been to find out the persons who keep such records, and one of the most obvious sources of assistance is the public press; I now, therefore, ask from each and every journal in the British Isles their all-powerful aid. When the collection was first organized in 1860, scarcely 200 persons were known to observe and record the rainfall; by steady perseverance, and the aid of a portion of the press, the number has been raised until there are now more than 1200 places whence returns are regularly received. Still I know there are many more, probably hundreds, who have either never heard of the establishment of a central depôt to which copies of all rain-records should be sent, or have been too diffident to send them. It is of paramount importance to gather these, and make the tables yet more complete. I therefore beg leave through your columns to ask every reader to think for a moment if he or she knows of any one who keeps, or has kept, a rain-gauge, or who has any tables of rainfall (or old weather journals) in their possession: and if they do know of such persons, I ask them on behalf of science, of my fellow-observers, and on my own behalf, to use every effort to secure their assistance, and to favour me with their names and addresses. We want old records, we want records for the present year, and from many parts of the country we want returns for the future, if a few persons will notify to me their willingness to assist, and to pay 10*s*. 6*d*. for the very cheap and simple gauge now supplied.

To prevent needless correspondence, I annex a list of the places in Middlesex whence returns have been already collected for the years mentioned in the last column, and shall be very glad of any additions or corrections. Other counties, or the complete list for the whole country, shall be sent to any one willing to make good use of it. I may add that an influential committee of the British Association has been appointed to superintend and assist in my investigations, and that they cordially support my present application.

I am, Sir,
Your obedient Servant,
G. J. SYMONS.

136 Camden Road, London, N.W.

The Committee consists of J. GLAISHER, Esq., F.R.S., Lord WROTTESLEY, F.R.S., Prof. PHILLIPS, F.R.S., Prof. TYNDALL, F.R.S., Dr. LEE, F.R.S., J. F. BATEMAN, Esq., F.R.S., R. W. MYLNE, Esq., F.R.S., and myself.

MIDDLESEX.

Station.	Elevation.	Observer.	Period.
Camden Town	100	G. J. Symons, Esq.	C 1858–
Chiswick	...	Royal Hort. Soc.	1825–
Colney Hatch	...	R. G. Rose, Esq.	1857–
Edmonton	...	C. H. Adams, Esq.	1792–96
„	...	„	1811, 1816–40
„ (Lower)	...	Mr. J. Brown	C 1860–
Enfield (Back Hill)	89	W. Mylne, Esq.	1864–
„ (Vicarage)	110	Rev. J. M. Heath	1849–
Finchley Road	270	G. W. Moon, Esq.	C 1860–61 T
„	306	„	C 1860–61 T
Hackney	40	Dr. Tripe	1856–58, 1860–
Hammersmith	12	F. J. Burge, Esq.	1856–58, 1860–
Hampstead	360	R. Field, Esq.	C 1862–
Harrow-on-the-Hill	375?	Dr. Hewlett	1864–
Highgate	394	J. Cutbush, Esq.	C 1862–
London (Bryanstone Square)	93	C. O. F. Cator, Esq.	1861–
„ (Chiswell Street)	...	W. Fletcher, Esq.	1850–59, 1861–
„ (Crane Court)	...	Roy. Soc. Trans.	1729–35
„ (Gray's Inn Road)	55	Mr. Strachan	C 1862 T
„ (Guildhall)	50	W. Haywood, Esq.	C 1857–
„ („)	123	„	C 1857–
„ (Hatton Garden)	...	Mr. R. C. Woods	1838 imp.
„ (Mile End)	...	F. Charrington, Esq.	C 1862–
„ (Offord Road)	90	Mr. Strachan	C 1864–
„ (Somerset House)	150	Philos. Trans.	1774–81, 1787–1809, 1812–27, 1829–42 T
„ (Spring Gardens)	36	J. W. Bazalgette, Esq.	1863–
„ („)	95	„	1863
„ („)	95	„	1863
„ (Temple Bar)	...	Bent's Met. Jour.	1795–1807
„ (Westminster Abbey)	...	Dr. Heberden	1766–67 imp.
„ („ House)	65?	„	1766–67 imp.
„ („ Garden)	25?	„	1766–67 imp.
„ (Whitehall)	...	J. C. Haile, Esq.	C 1854–60
„	...	Nicholson's Journ.	1808–10
„	...	......	1817–21
„	...	Lady Bayning	1836–42 imp.
Notting Hill	...	S. B. Blunt, Esq.	C 1865–
Paddington	...	......	1854–56
Poplar	25	Mr. Gaster	C 1862–63 T
St. John's Wood (Lit. Soc.)	161	H. J. Montague, Esq.	1857–
„ (Melina Place)	...	G. Leach, Esq.	1852–57 imp.
Spring Grove	70	T. E. Wyatt, Esq.	C 1864–
Tottenham (Vicarage)	...	Rev. J. S. Winter	C 1861–62 T
„	60	Fowler	1842–45–
„ (Lordship Lane)	...	W. D. Howard, Esq.	1847–
Twickenham (Observatory)	24	A. Wiss, Esq.	C 1863–
Uxbridge (Harefield Park)	...	W. Vernon, Esq.	C 1864–
Winchmore Hill	...	Mrs. Feltham	C 1858–

To the Editor of the Proceedings of the Meteorological Society.

Greenwich, 1865, October 3.

MY DEAR SIR,—Last year the British Meteorological Society did me the honour to print in their 'Proceedings' a translation which I had prepared, at your request, of some remarks by Professor Lamont in the Reports of the Royal Academy of Sciences at Munich "On the Ten-year Period of the Magnetic Variation, and of the Solar Spots." Professor Wolf has recently published another (the 18th) of his "Communications on Solar Spots," a great part of which has already been printed in an English form in the 'Monthly Notices' of the Royal Astronomical Society*. As a kind of supplement to that communication he makes several remarkable strictures upon the paper of Lamont's to which I have referred, as well concerning the magnetic variation as the solar spots. And these observations of his, it occurred to me, might possibly be of interest to the Meteorological Society: I therefore venture to enclose you a translation of them.

It may perhaps seem bold in me to offer any opinion upon the points in dispute; yet what astronomer can avoid subscribing to Lamont's remark that exact observation on the periodicity of the solar spots is so recent, that theorizing upon its length is premature, and that "not until the next twenty years shall have confirmed and augmented the existing foundations, and something more decisive be established concerning the possible magnitude of the variations from day to day, and concerning the side of the sun which is turned towards us and turned from us, &c., can the older observations be made of any service to the theory, while their immediate combination with the new, without any sifting, can only lead to untenable conclusions?" I also ask your indulgence whilst I make a few remarks on the magnetic periodicity alluded to. The reference made by Lamont to General Sabine's conclusion is surely, as Professor Wolf states it, "irrelevant to the point in question;" for the decennial period which the General claims to have detected is in the variation of "frequency and amount of the magnetic disturbances or storms." In regard to these, the Astronomer Royal, in a paper lately read before the Royal Society† "On the Inequalities of Terrestrial Magnetism," in which he discusses the magnetic disturbances observed at Greenwich for several years under your directions, states that "there is no appearance of decennial cycle in their recurrence." And in this view I know that you yourself concur.

Lamont's period (first announced in Poggendorff's 'Annals'‡) is in the amount of the mean diurnal variation of the magnetic declination in different years. In connexion with this, it will be interesting to cast a glance at the curves accompanying the paper in the 'Philosophical Transactions' I have quoted, which represent the diurnal change for seventeen years (1841 to 1857) in the magnitude and direction of the magnetic forces in the horizontal plane as observed at the Royal Observatory. "From 1841 to

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* Vol. xxv. p. 216. † Phil. Trans. 1863, xiii. ‡ Vol. lxxxiv. p. 579.

1848," as the Astronomer Royal remarks, "their magnitude very slowly increases with a small change of form. From 1848 to 1857 their magnitude very rapidly diminishes with a great change of form." We have therefore, indeed, a minimum about 1856 or 1857; but no appearance whatever of another minimum ten years anterior to that, or of a maximum between them, or of anything else at all indicative of a decennial cycle. May we not then assume that here also has been a somewhat premature attempt at forming a theory? I am, my dear Sir, yours very truly,

W. T. LYNN.

J. Glaisher, Esq., F.R.S.

LIST AND NOTICE OF BOOKS PRESENTED SINCE MEETING OF NOVEMBER 15, 1865.

American Philosophical Society, Proceedings of. No. 73. Principal contents:—

On the Effects of Impure Air on Health.—Briggs.

On the Heights of Auroras.—Marsh.

On Petroleum, &c.—Sheafer and Lesley.

On the Relation of Gravity to the Vertical Deflection of the Magnetic Needle.—Chase.

Annuaire de la Société Météorologique de France. 10th vol. 1862. Containing:—

Meteorological Observations at Blois during the year 1860. —Dr. Lunier.

Meteorological Observations at Laval (Mayenne) during the years 1803–14.—MM. Maupetit and Buquet.

This series consists of daily barometrical and thermometrical observations, records of rainfall, the direction and strength of the wind, and state of the sky. After May 1808, hygrometrical observations were added to the list and continued to 1814.

M. Lorière says, "Ces observations paraissent avoir été faites avec beaucoup de soin et à cette époque sont excessivement rares."

Bulletino Meteorologico for January and February 1865.

Meteorological results from 1859 to 1864.

Magnetic Needles, Mechanical Polarization of.—Chase.

The instrument used was a Gaussian modification of Faraday's apparatus for showing the electric currents developed in moving metallic bodies by terrestrial magnetism. The results of a number of experiments are appended and discussed.

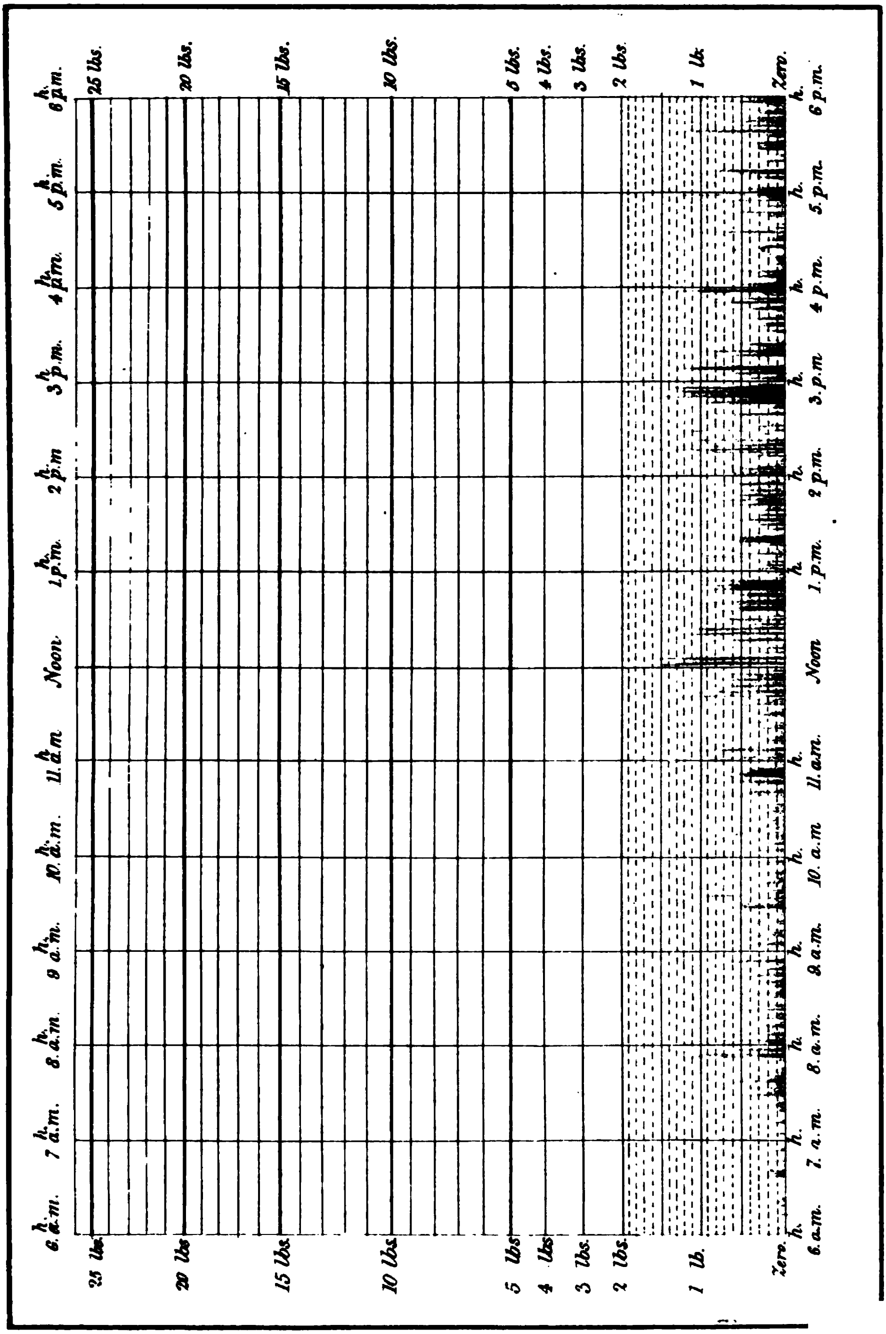
Meteorological Commission, Cape of Good Hope. First Report 1862.

Observations Météorologiques faites à Nijné-Taguilsk. 1864.

Osservazioni Meteorologiche. Milan: Giovanni Capelli, 1864.

Rainfall, 1862–63.—Symons.

Fac-simile of a portion of the recording Sheet of Cator's Anemometer; showing also the pressure of the Wind recorded on 18th January 1865. from 6h a.m. to 6h p.m.



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OF THE

BRITISH METEOROLOGICAL SOCIETY,

SESSION 1865–66,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1865. November	15		1866. March....................	21
1866. January	17		„ April	18
„ February.................	21		„ June	20

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PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, Esq., F.R.S., Secretary.

1866, FEBRUARY 21.

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THE METEOROLOGICAL SOCIETY.

This Society was established in the year 1850, for the encouragement and promotion of Meteorological Science, and incorporated by Royal Charter in 1866.

It consists of Fellows and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Fellows, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

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Six Ordinary Meetings are held during the Session, which commences in November and terminates in June, at which Fellows can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Fellow of the Society*. The 'Proceedings' also contain Notices of Books, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Fellows of the Society, at about 60 different stations, which are forwarded monthly to Mr. Glaisher, by whom each reading is examined and collated with readings made in adjacent stations, their means taken or examined, and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of Mr. Glaisher's 'Quarterly Meteorological Report' *is sent free to every Fellow of the Society.*

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The Society possess a Library, which is available to Fellows.

The address of the Treasurer, H. Perigal, Esq., to whom subscriptions may be paid, is 57 Warren Street, Fitzroy Square, W.

Gentlemen desirous of joining the Society may communicate with either of the Secretaries.

1866, March 1.

JAMES GLAISHER, F.R.S.,
Dartmouth Place, Blackheath, S.E.
JOHN W. TRIPE, M.D., 7 King's
Place, Commercial Road, E.
} *Secretaries.*

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. III. 1866, FEBRUARY 21. [No. 23.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

J. William Luck Blore, Esq., Secretary Government Meteorological Commission, Cape of Good Hope;
Thomas Henry Davis, Esq., Orleton, Worcestershire;
William Frederick Harrison, Esq., Bartropps, Weybridge, Surrey;
were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society were read.

CXV. *On the Daily Weather Diagram for* 1865, *and the Comparisons of the Curves of each of the Elements delineated thereon with each other, and with the Weekly Imperial Average Prices of Wheat and with the Mortality.* By C. O. F. Cator, Esq., M.A.

The principle on which this diagram is based, is the same as that for 1864, viz. to bring together some of the more important meteorological elements, and to show in one view their daily variations and their corresponding relations with each other during the whole year; and it seems that for this purpose a diagram with curves for each element, one superposed over the other, is far preferable to a table of figures. The weekly imperial average price of wheat and weekly mortality have also been added, to show how far they may have been respectively influenced by the changes of the weather.

It is proposed, as in 1864, first to consider each element separately, and then to compare its changes with those of every other element.

Part I.

I. Pressure of the Atmosphere.
II. Wheat Averages.
III. Temperature.
IV. Direction of Wind.
V. Mortality.
VI. Rain.

I. *Pressure of the Atmosphere.*—The year commenced with the reading of the barometer moderately high, viz. about 29·9 inches, and with the exception of a fall of 0·5 inch on the 2nd, remained so generally till the 11th; then followed a long period of low pressure till February 6, viz. twenty-six days; including that remarkable period January 13, 14, when the barometer fell to 28·6 inches; at Liverpool at the same time to 28·37, at Clifton 28·54, and at Beeston 28·40 inches, on the 14th a strong gale having raged all over England. From February 8 to 14 the pressure was very high, reaching 30·555 inches on the 10th, and from 15th to 20th very low, being 29·11 on the 16th; thence till the 8th of March the readings were unsteady, but neither particularly high nor low; from the beginning of the year till this time (March 8th) there were very great fluctuations in the readings. From January 8 to February 8 they never rose to 30 inches, and from March 8 to 25 were pretty steady, with generally fine weather. On the 25th there was a sudden fall of 0·5 inch, succeeded as suddenly by a rise of 0·7 inch, from which time till May 3 the readings were remarkably high, and with little variation till May 8, only twice, between March 27 and May 2, falling below 30 inches. During this same time, viz. April 1 to 28, occurred that very remarkably fine and hot weather for which this month was so conspicuous, and all the more so, coming as it did so suddenly after the long protracted winter, which only left us on March 29. In the month of April there were no less than fourteen cloudless or nearly cloudless days, and the entire range of the barometer was only 0·46 inch. From May 8 to June 2 there were greater fluctuations, and from that time till June 29 was the most steady period of the year; but there was not such fine sunny weather as in April, there being only seven cloudless days in June. This steady period was suddenly interrupted on June 29, 30 by a fall of 0·80 inch, accompanied by rather strong wind, and the heaviest daily fall of rain of the year on June 30, on which day 1·164 inch fell. Then the readings increased 0·8 inch rather quickly, and remained very steady near 30 inches till July 23, the range from the 6th to 23rd being only 0·29 inch; then the readings were very high for a week, with very fine weather, which broke up on the 31st, with a fall of the barometer to 29·74 inches; and the readings remained generally low, but without much fluctuation, till the 24th of August, during which time was very bad weather; and from this day till October 7, was another long period (forty-four days) of a remarkably high barometer (but not nearly so steady as in June), the readings only twice descending below 30 inches, and not once so between August 29 and October 2; and during all this time the most magnificent weather prevailed all over Great Britain, and was, I believe, predicted by Lord Portarlington. From October 8 to November 1, the barometer readings were subject to great fluctuations and were very low, with corresponding bad weather, but without much wind, till October 25, on which day was a sudden fall of 0·8 inch, and a gale of wind. From November 1 to 19 the readings were high, and thence to December 6 very low, with much fluctuation, and frequent gales of wind, 18 lbs. on the square foot being the *maximum* pressure on November 24. From December 4 there was a great and continuous increase, from 29·39 inches (on which day there was a gale of wind, 7·5 lbs. on the square foot being the *maximum* pressure) to 30·7 inches on December 11, which was the highest point reached by the barometer since January 9, 1859, and again about the same height on the 15th of December; the readings remained above 30 inches till the 29th, when there was a very rapid fall to 29·22 inches, accompanied by a heavy gale of wind, and they remained low to the end of the year.

On looking at the diagram, it will be seen that there were much greater fluctuations from January 1 to March 7 and from October 7 to December 6 than between March 7 and October 7. The *minimum* of the year was 28·653 inches at the height of

93 feet above the sea-level on January 14th, and the *maximum* was 30·710 inches on December 15. During the year the reading of the barometer was above the average, uncorrected (29·977), or high on 192 days, and below the average, or low, on 150 days, and five days just the average. This would help to confirm what was remarked last year, viz. that the curve when low is more pointed, and when high more flat, than it is when high and low respectively. For instance, see January 14 and 26, February 16 and 18, March 5 and 25, June 30, &c. for low readings, and April 18 to May 2 and June 12 to 27, &c. for high readings. During the whole year the barometer rose *sixty-seven* times, and fell *sixty-six* times. From this it would seem that the readings, on the whole, rose and fell equally rapidly. Of all the months September had the highest mean, and January the lowest. Considering the maxim "Long foretold long last, short notice soon past," it seems that the first part held good in June; for after the steady rise in the barometer from June 2 to 8 the readings remained high till the 29th, with fine weather. In other cases it does not seem to have held good; for instance, after the long warning from January 7 to 14, the barometer falling all the time, it no sooner reached its lowest point than it rose again immediately, with fine weather for twelve days; see also the long rise, February 1 to 10, when it fell again immediately; also the long fall, February 10 to 16, and October 4 to 11, &c. The latter part, "short notice soon past," held good oftener; for instance, the falls on January 25, 26, March 4, 5, and 25, June 29, &c., were very soon succeeded by rises, and the rises on January 27, 28, February 19, 20, and those during the latter half of November were very soon succeeded by falls. Yet in a great many cases this latter part does not hold good; for see the sudden rise on March 26, June 30, July 1, October 30, November 1 and December 4 to 8, &c., after which the readings remained high for a long time.

II. *Wheat Averages.*—The increase in the price of wheat during the year was great. The year began with the low price at the end of 1864, viz. 38*s*. 2*d*., remained steady till the end of March, then gradually increased to 46*s*. 7*d*. at the end of August, fell again below the average to 40*s*. 10*d*. at the end of September, and then rose very quickly to 46*s*. 11*d*. in the middle of November, and remained nearly steady at this high price to the end of the year.

III. *Temperature.*—This cannot be so easily divisible into well-marked periods as last year. The year came in with cold weather, which, however, only lasted three days, and was succeeded suddenly by warm weather, which lasted till the 16th of January; then there was a fortnight's cold weather till the 30th, from which time till February 8, there were frequent alternations between heat and cold, and from then till the 22nd cold prevailed, five days of which (11 to 15) were very cold, the morning of the 15th being the *minimum* temperature of the year, viz. 20°·5; February 23 to March 3 was again warm, and from March 4 to 30 the temperature was very uniform, and was unusually low, particularly the last fortnight, when there was severe frost, every day in this long period (twenty-seven days) being below the average; this was also remarkable for the very small diurnal range of temperature. From this unusually protracted winter we all of a sudden jumped, so to speak, with only a few days (March 31 to April 5) as a stepping-stone intervening, into *summer*; for from April 6 to 28 was the most extraordinarily fine, hot, and dry weather, there being in fact (as Mr. Glaisher states in his valuable remarks on the weather in the 'Registrar-General's Quarterly Returns') no other April on record having so high a temperature. In this month also the very *large* diurnal range of temperature was as remarkable as the very *small* amount thereof in March. The mean diurnal range of this month was the greatest in the year. Another contrast between this month and March, every day from the 4th to 28th, was *above* the average, as every day from March 3 to 31 was *below it*. Then on 29th of April was a sudden fall of 12° of mean temperature from the previous day, and it continued cold for three days only, then almost as sudden a rise to hot weather again by May 3; it continued generally warm till the 9th, then came the usual but unaccountable cold week, May 10 to 16 (but not with east wind). From this time till July 30, the temperature continued very high, with the exception of a few days, now and then, slightly below the average; June 23 and July 27 being the two hottest days in the year, their respective values being 84° and 84°·5. The daily range of temperature in these three months, particularly June, was also large, but not so large as in April. Then from July 30 followed a week of very cold weather for the season, and from that time till August 31 the temperature was remarkably uniform, and very near the average, after which came that excessively hot and fine weather, for which September (which was the hottest on record) was so conspicuous: there was a well-marked and very hot period till September 20 (the autumnal equinox), then a sudden fall of about 8°, and another well-marked period (also hot for the season) till October 17: between August 31 and October 13 (forty-three days), the mean temperature *only once* descended below the average! [From August 24 till October 8 was one of the most extraordinary periods ever known for drought and heat.] From October 17 to November 16, the temperature was generally low for the season, but far from uniform; thence till the end of the year it was nearly always above the average; the week November 19 to 25 very much so, with small daily range, and accompanied by very high winds. *The six months, April to September* inclusive, were the hottest six months on record, as Mr. Glaisher has informed us; and this is all the more remarkable, when we remember that one of them (August) was nearly 1¼° below its average. From October 9 to 19, there was a great fall of mean temperature, viz. 19°, with an intermediate stepping-stone on the 17th, which *fall* answered to the great *rise* of temperature above mentioned, viz. March 31 to April 6.

TABLE of Temperatures and Differences of Temperature between London and Greenwich, or between Town and Country.

Months.	Days.		Nights.		Mean.		Differences, London *minus* Greenwich.			
	London.	Greenwich.	London.	Greenwich.	London.	Greenwich.	Days.	Nights.	Means.	Daily ranges.
	°	°	°	°	°	°	°	°	°	°
January	41·2	40·9	33·2	31·8	37·0	36·3	+0·3	+1·4	+0·7	−1·1
February	42·1	42·2	33·5	32·2	37·4	36·6	−0·1	+1·3	+0·8	−0·4
March	42·9	44·0	32·7	31·1	36·7	36·6	−1·1	+1·6	+0·1	−2·7
April	64·0	66·3	44·3	41·5	52·6	52·3	−2·3	+2·8	+0·3	−5·1
May	66·7	67·9	49·1	46·3	56·2	56·1	−1·2	+2·8	+0·1	−3·9
June	71·6	73·6	53·1	49·9	60·6	60·2	−2·0	+3·2	+0·4	−5·2
July	74·9	75·7	56·9	54·3	64·0	63·8	−0·8	+2·6	+0·2	−3·4
August	70·2	70·9	53·8	51·5	60·3	59·9	−0·7	+2·3	+0·4	−3·0
September	73·7	76·4	56·9	53·6	64·0	63·9	−2·7	+3·3	+0·1	−6·0
October	58·7	60·0	46·1	43·7	52·4	50·9	−1·3	+2·4	+1·5	−3·7
November	51·1	50·8	41·2	38·7	46·2	44·8	+0·3	+2·5	+1·4	−2·2
December	48·2	46·7	40·6	38·1	44·4	42·4	+1·5	+2·5	+2·0	−1·0
Means	58·8	59·6	45·1	42·7	51·0	50·3	−0·8	+2·4	+0·7	−3·1

13°·74 was the average daily range at London, being 0°·6 greater than in 1864.

It appears from this Table, that in January and November the *days* in London were 0°·3, and in December 1°·5 warmer than at Greenwich, but that in every other month they were colder, the difference not increasing, as in 1864, with the mean temperature, but being greatest in April, June, and September, all three of which months were so very remarkable for drought, rain having only fallen in these months five, four, and two days respectively; and in all the other months, excepting February (when it was only 0°·1), the difference was about the same, viz. 1°. The mean high day temperature for the year was 0°·8 lower in London than at Greenwich.

The *Nights* were in every month, as in 1864, colder at Greenwich than in London; in June and September as much as 3¼°, and January, February, and March only 1½°, and in all the other months about 2½°, the greater amount in June and September being due no doubt to the greater amount of nocturnal radiation in those dry months, the effect of this being much more felt in the country than in town.

The *Daily Range* of temperature was greater in 1865 at Greenwich than in London in every month, the excess least in the winter months, and the greatest in April, June, and September, being from 5° to 6° in these three months. From this it appears that the drier the weather, the greater the difference of range of temperature between town and country. The mean yearly difference of daily range between London and Greenwich was 3°·1, being about the same as in 1864.

IV. *Direction of Wind.*—After two days of east wind, west wind prevailed till January 21, then variable till February 2, east and north-east till the 16th, westerly again till March 10, north-east till the 22nd, then after three days west wind, easterly till March 29, west and south-west till April 8, then a prevailing east wind (with a few exceptions) till the 31st, then variable till May 9, west and south-west till June 3, variable till the 13th, east-north-east till the 22nd, west-north-west for four days, east-south-east for four days, then west-south-west generally from July 2 to 20, easterly till the 26th, then west-south-west, with one or two days of north-east intervening, till September 11, then north-east and south-east, with two days of south-west intervening, till October 9, then very variable but chiefly westerly till November 4, north-north-east till the 9th, variable again till the 17th, south-west till the 26th, then prevailing east-south-east till December 9th, then northerly till the 17th, and from this time generally south-west, to the end of the year, and accompanied by very high winds during the last four days.

The following Table shows the number of days on which the wind blew from each point at 9 A.M.

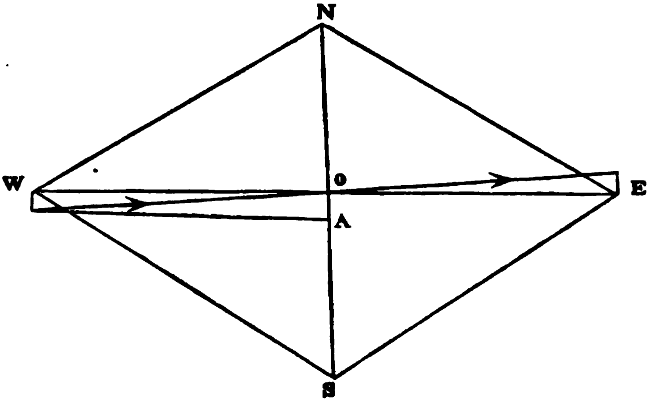
Months.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
January	3	1	3	2	...	1	1	...	1	1	5	3	6	2	2	...
February	2	1	2	1	4	1	1	1	1	...	8	2	1	2	1	...
March	4	3	3	2	2	2	...	...	...	...	1	4	2	1	5	2
April	1	3	4	2	6	...	1	...	1	...	1	4	6	1	...	...
May	...	...	2	...	3	1	3	2	1	...	9	4	5	...	1	...
June	...	...	9	1	5	...	1	...	1	1	1	1	2	2	5	1
July	...	1	4	...	1	2	1	...	1	2	6	5	6	1	1	...
August	...	...	2	2	...	...	1	...	1	3	8	5	3	3	1	2
September	1	2	4	2	8	1	...	1	2	...	...	6	2	1	...	...
October	1	1	3	3	6	1	1	...	1	...	3	6	4	...	...	1
November	1	4	2	1	2	3	...	2	...	3	3	3	2	4	...	...
December	2	3	1	1	1	1	4	4	...	1	7	1	2	...	3	...
Totals	15	19	39	17	38	13	14	10	10	11	52	44	41	17	19	6

Or, condensing the above,

N. = N. +½ N.N.E. +½ N.N.W. = 27½
N.E. = N.E. +½ N.N.E. +½ E.N.E. = 57
E. = E. +½ E.N.E. +½ E.S.E. = 53
S.E. = S.E. +½ E.S.E. +½ S.S.E. = 25½
S. = S. +½ S.S.E. +½ S.S.W. = 20½
S.W. = S.W. +½ S.S.W. +½ W.S.W. = 79½
W. = W. +½ W.S.W. +½ W.N.W. = 71½
N.W. = N.W. +½ W.N.W. +½ N.N.W = 30½
365

Or, further,

N. = N. +½ N.E. +½ N.W. = 71¼
E. = E. +½ N.E. +½ S.E. = 94¼
S. = S. +½ S.E. +½ S.W. = 73
W. = W. +½ S.W. +½ N.W. = 126½
365



$$NO : EO : SO : WO :: 71\tfrac{1}{4} : 94\tfrac{1}{4} : 73 : 126\tfrac{1}{2}.$$

Westerly over easterly	$32\tfrac{1}{4} = \frac{129}{4}$
Southerly over northerly	$1\tfrac{3}{4} = \frac{7}{4}$.

Therefore, take $\dot{O}A : OW :: 7 : 129$, and complete the parallelogram O A; the diagonal through O is the mean direction of the wind=about W. by S.

V. *Mortality.*—The weekly number of deaths in London are taken from the Registrar-General's Returns, as in last year's diagram; they have been in every case attributed to the seven days from Thursday to Wednesday, *i. e.* to a period beginning and ending three days previous to the period of registration, in order to give the recorded mortality to its true dates. The year came in with a high mortality, the returns being above 1500 every week till the second week in April, the *maximum* for the year being 1733, in the week ending February 1; they were slightly below the estimated weekly numbers till the second week in June, they were then above the average, with one exception, till the first week in August, the deaths reaching 1536 in the first week of July; they were then below or near the average till the first week in October; they then increased through October, November and December to the end of the year, reaching 1603 in the week ending December 27. The *minimum* for the year was 1131 in the week ending August 30. Taking the whole year together, the mortality was probably lower than might have been expected, considering the great unhealthiness which prevailed through the greater part of 1865 in so many other countries. It is evident from this that a registration of deaths by no means indicates the amount of sickness.

VI. *Rain.*—The *Rainfall* was very different in 1865 from 1864. The year 1865 was very remarkable for many heavy falls, and also for long periods of great drought. Although the total fall was 28·483 inches, yet it was only measured on 160 days, being only twenty-five days more than 1864, when the total fall was 10·7 inches (or 38 per cent) less than in 1865. Instead of there being only two heavy daily falls as in 1864, there were fourteen days (five of them in October) in which 0·5 inch or upwards fell, ten days in which 0·75 inch or upwards fell, and three days when 1 inch or upwards fell. There were three very wet months, January, August, and October, and two very dry ones, April and September; and June might also be called a very dry one, if considered so by the number of days on which rain fell, for from the 4th to the 28th inclusive, no rain was measured, yet in the month the whole amount which fell amounted to 2·295 inches (which is not far from the average amount), and that only on four days; 0·925 inch having been measured on the 2nd, and 1·164 inch (the heaviest fall of the year) on the 30th.

TABLE showing the Monthly Fall of Rain.

Months.	Amount in inches.	Days on which any measurable amount of rain fell.	Days on which 0·01 inch or upwards fell.
January	3·476	17	17
February	1·841	20	20
March	1·116	14	12
April	0·394	5	5
May	2·849	16	15
June	2·295	4	4
July	2·180	14	14
August	4·839	19	17
September	0·621	2	2
October	5·815	19	19
November	1·933	18	17
December	1·124	12	12
Totals	28·483	160	154

The fall of Rain in 1865 was about 4 inches above the average.

PART II.—COMPARISONS.

We now come to compare the different elements one with another, as per the following sketch:—

I. Pressure of the Atmosphere with
    1. Lunations
    2. Temperature
    3. Direction of Wind
    4. Rainfall
    p. 80–83
II. Wheat Averages with
    1. Temperature
    2. Mortality
    3. Rainfall
    p. 83–84
III. Lunations with
    1. Temperature
    2. Direction of Wind
    3. Rainfall
    p. 84–86
IV. Mean Temperature with
    1. Direction of wind
    2. Mortality
    3. Rainfall
    p. 86–87
V. Direction of Wind with
    1. Mortality
    2. Rainfall
    p. 87–90
VI. Mortality with
    Rainfall p. 90–91

I.—*The Pressure of the Atmosphere* with each of the other elements.—1st. There seems nothing particularly worthy of remark in comparing the fluctuation of the *readings of the barometer* with the *lunations, &c.*, except that when the moon was in perigee the readings were nearly always at or near the average height, and that at eight out of the twelve last quarters of the moon the readings were high.

2ndly. In comparing the curve of the *reading of the Barometer* with that of the *Mean Temperature*, it appears that out of 228 days, in which the temperature was above the average, there were 187 when the barometer-readings were also above the average, and only 41 when they were below it; and on the other hand, out of 137 days in which the temperature was below the average, there were 82 days when the barometer-readings were high, and 55 when they were low; in the former case in the proportion of 4½ to 1, in the latter of 1½ to 1. These results will appear best from the following Tables.

Temperature above or below the average.	Periods.	Days.	Barometer. Number of Days	
			Above average.	Below average.
Below	January 1–3	3	1	2
Above	January 4–16	13	8	5
Below	January 17–30	14	3	11
Mostly above	January 31–February 8	9	4	5
Below	February 9–22	14	10	4
Above	February 23–March 3	9	7	2
Below	March 4–30	27	16	11
Above	March 31–April 28	29	29	0
Below	April 29–May 1	3	3	0
Above	May 2–9	8	6	2
Below	May 10–16	7	4	3
Mostly above	May 17–June 10	25	23	2
Mostly below	June 11–19	9	9	0
Above	June 20–25	6	6	0
Below	June 26–July 1	6	4	2
Above	July 2–9	8	8	0
Below	July 10–13	4	4	0
Above	July 14–30	17	17	0
Mostly below	July 31–August 19	20	12	8
Above	August 20–October 12	54	46	8
Mostly below	October 13–November 11	30	16	14
Mostly above	November 12–December 31	50	33	17

	Temperature above average.			Temperature below average.			
	Days.	Barometer above average.	Barometer below average.	Days.	Barometer above average.	Barometer below average.	
		days.	days.		days.	days.	
Winter	13	8	5	3	1	2	Winter
	9	4	5	14	3	11	
	9	7	2	14	10	4	
Spring	29	29	..	27	16	11	Spring
	8	6	2	3	3	..	
	25	23	2	7	4	3	
Summer	6	6	..	9	9	..	Summer
				6	4	2	
	8	8	..	4	4	..	
	17	17	..	20	12	8	
	54*	46*	*8				
Autumn	50	33	17	30	16	14	Autumn
	228	187	41	137	82	55	

* N.B. Some of these days belong to Summer and some to Autumn.

From this last Table it appears that in all the four quarters of the year, with the temperature either above or below the average, except those parts of the winter months when the temperature was below the average, the number of days with the barometer-reading above the average exceeded those with the barometer-reading below it; but that, in the exception just named, the number of days with the barometer below the average exceeded the number of days with the barometer above it. From this we may gather that cold weather in the winter of 1865 occurred with a low barometer more than with a high one.

3rdly. In comparing the *Barometric curve* with the *Direction of the Wind*, it seems that in nearly all periods of any continuance of north, north-east, or east wind, the curve was either rising, high or steady, except June 28 to July 1, when there was a sharp dip in the curve, with a gale from north-east, and a heavy fall of rain; and on August 23 the barometer continued to fall with north-easterly wind, having fallen for three days previously with a west-south-west wind; and on that day also was a heavy fall of rain, this happening just at the end of the wet period, from July 31 to August 24, and before the very long dry one to October 8; and in the month of October, after the eighth day (with the exception of the 14th to 16th), the curve seemed to be as low with north-east wind as any other direction of wind, this having been a very wet period. In some cases we find that, with a west-south-west wind following a north-east or east wind, the curve continues to rise after the north-east wind has gone; for instance, north-east January 1 to 3, followed by a south-west and west wind, the curve rose from the 3rd to 7th 0·93 inch. Again, east and north-east June 28 to July 1, with a *fall* of 0·92 inch, was succeeded by south-west wind, and a *rise* in the barometer of 0·84 inch. Again, October 30 the readings increased 0·1 inch with north wind, and then increased three days with west wind 0·7 inch more, and then remained high, with only a slight increase with north-north-east wind.

It is also worthy of remark during that long continuence of fine weather in September, that there was prevailing westerly wind till the 11th, with a very steady barometer-curve; then, although the wind changed suddenly round to the east on September 12, and remained so, nearly constantly, till the break-up of the fine weather October 8, the same fine weather still continued, with a very high barometer-curve, although not quite so steady as previous to the 11th of September.

4thly. Next, comparing the *Barometric curve* with the *Rainfall*, in most cases of a rainy period, as might be expected, a corresponding dip in this curve was found, with a few exceptions, which are worthy of remark, viz. 7th of May, the barometer reading steady above 30 inches 0·40 inch rain fell; on the 11th of May, the reading increasing all the time, 0·425 inch rain fell, but this was after a fall of 0·764 inch rain on the previous day, the reading of the barometer having fallen from the 7th to the 10th. On the 2nd of June 0·925 inch fell, but there was only a small fall of the barometer. Then on the 22nd of July, the curve having been very steady from the 7th, it began to rise still further, and continued to do so till the 26th; and on the 23rd 0·431 inch of rain fell, the barometer-reading increasing all the time, and it being the second day of a four days' continuous increase. Again, on the 3rd of August there was a fall of rain of 0·842 inch, yet the barometer was rising all the time. On September 21, with a rising barometer, but immediately succeeding a decrease of 0·37 inch in the reading, 0·429 inch rain fell, but at Greenwich only 0·16 inch of rain fell; this was with a north wind, with a decrease of 8° in the mean temperature from the day before, and it was a very partial rain. On the 22nd of October, when 0·876 inch of rain fell, the barometer-reading only decreased 0·2 inch. It is worthy of remark that from October 8 to the end of the month, while the barometer-readings were very low and subject to much fluctuation, there was a great deal of *rain*, and very little *wind*, there being only one day (the 25th) when it might be considered very strong; on the other hand, in the latter half of November, while the barometer-readings were equally low and fluctuating, there was a great deal of *wind* and many gales, but only small quantities of *rain*, although frequent.

II.—1. *Wheat averages with Temperature.*—During the three winter months January, February and March, the price of wheat was remarkably uniform, varying only 8*d.* per quarter, and then when the great rise in the temperature took place during the next fortnight, there was also a rise of 1*s.* 9*d.* per quarter; then it remained pretty steady during the fine weather to the end of April, and then rose gradually to the second week in July, when it was 3*s.* 6*d.* per quarter dearer than at the end of April, the mean temperature after the second week in May also for the most part rising, it having increased 10° to 12° since the end of April; the price remained pretty uniform all through the hot weather of July, and became 10*d.* per quarter less by the second week in August, the mean temperature having also become about 15° lower by the first week in that month; then the price rose again very quickly 4*s*. 7*d*. by the end of the month and beginning of September, and just at this time the mean temperature rose 10°; and by the middle of September wheat had fallen again 4*s*. 7*d*., or nearly to the average of the year, and it fell 1*s*. 2*d*. further by the end of the month, and during the last fortnight in the month there was also a decrease in the mean temperature of 12° to 15°; but after this, while the temperature continued to decrease, the price of wheat increased again and very quickly, to the highest price of the year in the middle of November, and remained high to the end of the year. Down to the end of September, there seems to have been in a slight degree, a similar rise and fall in the generality of the curves, but after September they took quite opposite courses; probably there was some extraordinary cause (as the cattle disease) to account for this.

2. *Wheat Averages with Mortality.*—If not assuming too much, it may be just worth mentioning that these two curves seem to have taken opposite courses till the end of August, and after September the same courses; for during the first three months of the year, while the price of wheat remained steadily *low*, the mortality remained steadily *high*, then while the price of wheat rose to the end of May, the mortality fell during the same time; and during June there was a fall in the price of wheat, and the mortality rose, and after that wheat rose again, almost to the *maximum* of the year at the end of August, and the mortality fell to the *minimum* of the year; but after this, while the price fell again, the deaths remained about the same, and then they both rose together to the end of the year.

3. *Wheat Averages with Rainfall.*—The only points at all noticeable in comparing these, seem to be in the fall of the price of wheat during the *dry* weather of June, the great rise during the last fortnight of the *wet* weather in August, and the great fall again during the month of *very dry* weather, 26th of August to the 23rd of September; after this, although the dry weather continued, the prices rose, not only to the end of it, at the 8th of October, but all through the following *very wet* period.

III.—1. Next, comparing the *Lunations* with the *Mean Temperature*, the chief points to be remarked are these, viz. that at the time of first quarter the mean temperature was always either at or above the average. And that at the time of six of the new moons, there occurred a dip in the curve of the mean temperature, whether it was above or below the average at the time. Also that during ten of the periods between first quarter and full moon the temperature was above the average.

It may also be worth mentioning that the full moon of January 11 was nearly coincident with the top of the peak (so to speak) of the mean temperature curve in January; that the new moon of January 27 just preceded the great rise of temperature at the end of the month; again, that the new moon of March 27 just preceded the great rise of temperature at the end of March before referred to; and that the new moon of April 25 just preceded the great fall of temperature at the end of April; and that the two periods, February 28 to March 31, and March 31 to April 28, which appear well-marked in the curve of mean temperature as concave and convex respectively, followed by two days the two periods between the new moons of February 25 and March 27, and March 27 and April 25 respectively. Two of the three hottest days in June occurred on the days of full and new moons, viz. the 9th and 23rd. The new moon of September 19 just preceded the great fall of temperature on September 20. September 21 to October 17, a well-marked period, was just bounded by two new moons, as also was the generally cold period, October 18 to November 16.

2. There does not seem any particular coincidence of change of *moon*, with change or direction or duration of *wind* from any particular quarter.

Collecting these together, we find that the seven above-mentioned new moons happened at the time of four rises and three falls in the mean temperature, this being exactly the same in 1864 in every respect as to the new moons, which therefore would help to confirm the remark made in the paper on the diagram for that year, viz. that the great changes in the mean temperature took place at the time of new moons: there do not seem to have been any peculiar changes of temperature at the time of any of the other new moons in 1865, or at the times of any of the full moons or first or last quarters. This was also the case in 1864 as to first and last quarters.

3. Considering the LUNATIONS and *Rainfall* together, it appears that the greatest amount of rain fell about the time of the first quarter of the moon. The aggregate amounts which fell between the four quarters were as follows:—

Between new moon and first quarter—
8·477 in., or 30 per cent. of yearly total on 42 days.
Between first quarter and full moon—
8·916 in., or 31·5 per cent. of yearly total on 48 days.
Between full moon and last quarter—
5·974 in., or 21 per cent. of yearly total on 39 days.
Between last quarter and new moon—
5·116 in., or 17·5 per cent. of yearly total on 31 days.

Therefore the two wettest periods were between new moon and first quarter, and first quarter and full moon; and the amounts which fell in these were nearly equal, that in the latter of these being not far from double of that which fell between last quarter and new moon; and although the *number of days* on which rain fell in the first and third of the four periods were nearly equal, yet the *total amount* in the first is nearly half as much again as that in the third, which shows that the heaviest falls must have taken place in the first of these two periods, this appearing so in glancing over the diagram.

It seems worthy of remark, that the order of gradation of the amounts of rain which fell in the four lunar periods in 1865 was *exactly the reverse* of that of the respective amounts in the corresponding lunar periods in 1864, viz. that in 1865 the wettest was that between first quarter and full moon, and in 1864 it was the driest, and so forth.

IV.—1. *Temperature and Direction of Wind.*—It is at once apparent that in the winter months the temperature below the average occurred with wind from north-east or east, and above the average with west or south-west winds. There was a slight exception to this just after the vernal equinox, when there were three days of westerly wind, in the middle of a long period of easterly wind, and the temperature 6° below the average on each of those three days. In the summer months the temperature does not seem to be nearly as much influenced by the direction of the wind as in the winter; for in the first week in August there was a very low temperature with a westerly wind; and in September, although it was west and south-west every day till the 11th, and then easterly to the end of the month, yet the temperature continued high throughout. During the usual cold week in May, which this year happened from the 10th to 16th (being seven days), the wind was north-east only on two and a half of these, and west and south-west on all the others.

2. *Temperature and Mortality.*—The high mortality with which the year commenced was maintained throughout the first three months, although the temperature was several times above the average, yet the numbers of deaths were, to some extent, influenced by the temperature; for in each of the two cold weeks, at the end of January, the numbers were 160 and 190 more than in the week ending the 18th, and with the first week of February, which was warm, the deaths decreased again 184; but it is rather remarkable that the very cold weather in the middle of February brought with it hardly any increase in the deaths, these remaining pretty much the same till the third week in March, when the continued cold caused the number of deaths to rise 100; and they continued at this height, viz. between 1630 and 1680, till the first week in April, when the warm weather caused a decided decrease, which continued till the second week in May, being then 1167; and they remained without very much variation to the second week in June, the temperature having been chiefly above the average, and at times hot; they then increased 332 in three weeks to the 1st of July, when they were 1536, the temperature in the first week after such increase being low for the season, and in the next very high, and the next low again, which is curious; they then gradually diminished to 1131 in the last week in August, although the temperature was very high during the last seventeen days of July; then again, although the temperature was so extraordinarily high all through September, the mortality remained unexpectedly low, never exceeding 1214 till the second week in October; and then with a diminution of temperature, the numbers began to increase and continued to do so till the last week of the year, when they reached 1603, although the temperature during the last eleven weeks of the year was nearly all the time between 40° and 50°. On the whole, the mortality does not seem to have been so much influenced by the temperature as in 1864, or as might have been expected, especially in the summer, when there was only a moderate increase in the deaths notwithstanding the unusual heat of the season.

3. *Temperature and Rain.*—In 1864 rain fell chiefly in the winter months with temperature above the average, but in 1865, in consequence of the frequency of snow in January, February, and March, rain or melted snow was as often measured with temperature below as above the average, particularly January 26 and 27, when the temperature was very much below the average; 1·3 inch was measured. At other times of the year, rain generally

TABLE showing the Depth of Rain which fell with Wind from

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in	in.	in.	in.	in.	in.	in.
January 3·476	·022 ·011		·018 ·996	·030	·302		·180			·295	·253 ·050 ·104	·012 ·402	·033		·030 ·728 ·010	
February 1·841	·010				·020 ·019 ·085 ·060	·100				·478 ·172	·092 ·039 ·032 ·017 ·014	·091 ·097	·050 ·143 ·258		·048 ·016	
March 1·116	·124 ·075	·037	·007 ·046				·072 ·057				·152 ·202		·202 ·047		·037 ·001	·057
April 0·394			·102						·098	·037	·100			·057		
May 2·849			·764 ·077	·399			·186	·135 ·124	·047		·045 ·070 ·033 ·281	·020 ·148 ·088	·007		·425	
June 2·295			1·164		·098				·925		·108					
July 2·180		·095	·018 ·452	·431	·013				·173		·552 ·098 ·133 ·032	·013 ·104	·028	·038		

August 4·839	·147		1·114 ·007						·048	·058	·288 ·167 ·168 ·846 ·075	·192 ·006 ·312 ·104	·041	·383 ·842 ·033	·008	
September 0·621	·429											·192				
October 5·815		·648 ·235	·303	·053 ·205 ·876	·058 ·163		·612		·200 ·175	·813		·553 ·452 ·047 ·064 ·243	·098 ·017			
November 1·933		·013	·067 ·018 ·042				·163		·038	·005 ·197 ·222 ·160	·063 ·275 ·087 ·023 ·072		·253	·018		·217
December 1·124			·028			·022	·013 ·015	·236	·027	·010	·018 ·042 ·283 ·230	·200				
Totals......	·818	1·028	5·223	1·994	·818	·122	1·298	·495	1·731	2·447	5·044	3·340	1·177	1·371	1·313	·264
Days having any amount	7	5	17	6	9	2	8	3	9	11	34	20	12	6	9	2
Days +·25 in.	1	1	6	3	1	......	1	......	1	3	7	4	2	2	2	

fell synchronously with a dip in the curve of the mean temperature; for instance, on

May 7, 0·4 in. of rain fell, with a decrease of 5° of mean temperature from previous day.
May 9, 10 and 11, 1·38 in., with a decrease of 10°.
June 2, 0·925 in., after a decrease of 10°.
June 29 and 30, 1·26 in., after a decrease of 11°.
July 31 to August 4, 2·11 in., after a decrease of 19°.
August 23, 1·11 in., after a decrease of 6°·5.
September 21, 0·43 in., with a decrease of 8°.
October 18, 0·21 in., after a decrease of 6°.
October 19, 0·65 in., after a further decrease of 7°.

But in November and December rain seems to have fallen chiefly with a rise in the curve of the mean temperature.

V.—1. *Direction of Wind and Mortality.*—Taking those weeks when the number of deaths exceeded the number estimated with a correction for increase of population, and then those weeks when the numbers fell short of the estimated number, it is found that the number of the former when the easterly was the prevailing wind, bore to the number of the former, when the westerly was the prevailing wind, a proportion of 13 to 19; and on the other hand, that the number of the latter, when the easterly wind was the prevailing wind, bore to the number of the latter, when the westerly wind was the prevailing wind, a proportion of 5 to 9; from this we may conclude that when the mortality was *above* the average, the proportion of east wind to west wind was much larger than when the mortality was *below* the average, or

When mortality above average, E. : W. : : 13 : 19,
When mortality below average, E. : W. : : 5 : 9,

or that the mortality with east wind : mortality with west wind, as $\frac{13}{19} : \frac{5}{9}$, or as 117 : 95.

2. *Direction of Wind and Rain.*—The preceding Table (pp. 88 and 89) shows the aggregate amounts of rain which fell, with the different directions of the wind; also the number of days with the different directions of the wind on which any amount, and on which 0·25 in. or upwards, fell.

From this Table it is found that the greatest amount of rain fell with wind blowing from a generally south-westerly direction, but that from any *one* point the greatest amount fell from the north-east, viz. 5·223 inches, which slightly exceeded that which fell with a south-west wind, viz. 5·044 inches; this is to be accounted for from the fact that the heaviest falls of the year occurred with wind from north-east, viz. January 27, when the amount collected was 0·966 in.; May 10, 0·764 in.; June 30, 1·164 in.; and August 23, 1·114 in.; yet this is also remarkable, because the number of days with north-east wind when rain was measured was only 17, or just half the number with south-west wind, or that the rain from north-east was just double as heavy as that from south-west. But if we take the amount from a south-westerly point generally, *i. e.* adding to it half the amounts belonging to south-south-west and west-south-west respectively, we find it is 7·938 in.; and similarly the amount from a general north-easterly point is 6·734 in., which would appear to coincide more nearly with the general notion of the moist south-west wind. The driest quarter of the compass appears to have been the east-south-east.

VI. Lastly, *Mortality with Rain.*—The mortality exceeded the estimated number from the beginning of the year to the end of April, during which time there was both very wet weather (in January) and very dry weather (in April); then followed three weeks with mortality below the estimated number, and during the last two of them wet weather; then four weeks very near the estimated number, with partly wet and partly dry weather; then came seven weeks (with one exception) with the mortality a good deal above the estimated number, the first two weeks of which were very dry, and the remainder wet, and at times very wet; thence to the first week in October (eight weeks) the numbers of deaths were generally below or near the average, the first two being very wet, and the remainder very hot and dry; from that time, during four very wet weeks and two moderately dry ones, the numbers were above the average; then with four weeks of frequent but not heavy rains the mortality was below the average; then followed two weeks when it was above again, during which time there was hardly any rain, and the last week of the year it was slightly below the average, and there was much rain.

The results appear to be,

of 25½ *dry* weeks,
  the mortality was *above* the estimated numbers on 15½ of them;
  the mortality was *below* the estimated numbers on 2 of them;
  the mortality was *at or near* the estimated numbers on 8 of them:
and of 26½ *wet* or rainy weeks,
  the mortality was *above* the estimated numbers on 15 of them;
  the mortality was *below* the estimated numbers on 8½ of them;
  the mortality was *at or near* the estimated numbers on 3 of them.

Therefore in 1865 neither wet nor dry weather seemed to have raised the mortality above the estimated average, but that wet weather tended to keep the mortality as much below the average as dry weather to keep it at or near the average, *i. e.* if the presence or absence of rain exercised any influence at all on the mortality, independent of the temperature, direction of wind, or any other element.

CXVI. *On the Progress of Rainfall Investigations, and on Fluctuations in the Annual Fall of Rain.* By G. J. Symons, Esq.

It being rather more than three years since I have rendered a full account of my proceedings to this Society, it seems hardly desirable further to postpone it; moreover, it seems opportune at the apparent close of a period of drought to notice some of its most salient points. To these two separate questions I propose to devote this paper. First, to explain the steps that have been taken to increase and improve our means of observation; by which I do not refer merely to obtaining additional stations, but also improving and experimenting with every variety of instrument, and inducing habits of uniformity, increased care, regularity, and accuracy among the observers. Secondly, I propose to point out a few of the results of such temporary and partial investigations as the organization of the system, and that *collecting* which I hold to be my first duty, has afforded opportunity.

Under the first head we have to consider (1) Geographical distribution of stations; (2) Examination of instruments both before despatch and after erection; (3) Best form, size, and material for rain-gauges, as well as best height; (4) A variety of small matters desirable for determination; (5) The steps that have been taken to secure strict accuracy and uniformity; (6) The amount of information collected.

1. *Geographical distribution of stations.*—This is a point in which progress is not easily made evident, the mere numerical increase being no guide; it may, however, incidentally be mentioned that there are now at least twice as many observers as there were in 1861, the number of perfect returns for that year being 626, while at the present time there are between 1300 and 1500—certainly more than the former, and probably less than the latter.

A far better indication of the effective progress of this branch is afforded by the Tables appended to my last Report to the British Association (copies of which will shortly be forwarded to every observer). Take first Ireland. When I began my investigations in 1860, there were only eighteen persons observing rainfall in the whole country, and their results were never collected, and rarely published, now the number is quadrupled. Then there was no observer in Cavan, Donegal, Down, Kerry, Kilkenny, Londonderry, Meath, Roscommon, Tipperary, Tyrone, Westmeath, or Wexford, now there is one or more in each. Take again the central portions of Inverness and Ross-shire: I well remember the feeling of mortification that I felt on one or two occasions when this paucity of observers was brought forcibly home to me. Once it was an engineer who wanted information as to the rainfall in the east of Caithnesshire, and I had to tell him that I then (not having at that time obtained the lighthouse gauge returns) knew only of one year's observations having been made in any part of the county. On the other occasion, I was asked to supply a rain-gauge gratuitously because "there is no station within thirty miles of me in any direction, and to the N. or S. of me there is not one for 100 miles." Now, however, there is no part of Scotland more than twenty-two miles from one or more of my stations, or with any such sweep as fifty miles without one or more gauges. Lastly, I would take Wales. The returns for 1859 comprise eight stations, viz. Lampeter, Llandissillio, Llandudno, Hawarden, Holywell, Ystalyfera, Haverfordwest, and Rhayader. Now they number over 100, the returns of seventy-two being perfect for 1865 (or just nine times as many as in 1859); there is yet room for, and necessity for, several more, some important districts being quite unrepresented. I am glad to state that, in conjunction with Mr. Bateman, F.R.S., I am taking steps to obtain further observations from the Principality, and hope to make the representation yet more complete during the present year.

2. *Examination of instruments before and after erection.*—This most important matter has unfortunately not made such rapid progress as I anticipated and desire. True, several hundred gauges have been tested before despatch, but this affords no check as to the position in which they will be placed, on which it is almost needless to remark, almost as much depends as on the accuracy of the instrument. The really effectual and proper plan is to visit the whole of the stations and test at once the accuracy of the gauge and the suitability of its position; but the time consumed and labour

and expense involved is so great that little progress has hitherto been made, and up to the present time not one station in six has been visited. Hope, which carried me through the heavy pecuniary losses attendant on organizing the present corps of observers,—hope, I say, induces the belief that this year will see the number of stations already visited raised at least to 200 if not to 300, though as the average cost of visiting each gauge is quite 10*s*., it may be that the finances will not allow such a general visitation as I should like to carry out.

3. ***Best form, size, and material for rain-gauges, and best height at which to place them.***—This had received little attention from me until 1863, and was not even mentioned in the paper I then read to this Society. Subsequently it has assumed an importance few would have anticipated. In the summer of 1863, Colonel Ward, after some consultation with myself, decided on commencing the now well-known Calne experiments—consisting of two sets of gauges, one set of eleven gauges exactly alike in size and form, but at the various elevations shown in the diagram. The results hitherto obtained are shown in the following Table, and also on the diagram, from which it is evident that the deficiency in elevated gauges is nearly twice as great in winter as in summer.

TABLE I.

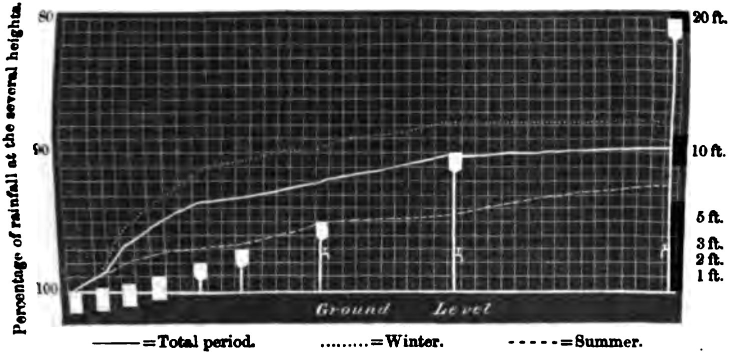
Rain collected at various Heights above the Ground at Castle House, Calne, August 1863 to December 1865.

Lat. 51° 27′ N., long. 1° 59′ W.; height above sea 250 feet.

[Gauges all Glaisher's pattern, 8 inches in diameter.]

Height of top of gauge above ground.	Summer Months. (=April to Sept.)		Winter Months. (=Oct. to March).		Total period.	
	Depth in inches.	Fall in level gauge being 1·000.	Depth in inches.	Fall in level gauge being 1·000.	Depth in inches.	Fall in level gauge being 1·000.
Level	27·113	1·000	40·155	1·000	67·268	1·000
2 inches ...	26·817	·989	39·783	·990	66·600	·990
6 inches ...	26·571	·980	38·289	·953	64·860	·964
1 foot	26·430	·975	37·566	·935	63·996	·951
2 feet.........	26·295	·970	36·610	·912	62·905	·935
3 feet.........	26·183	·966	36·415	·907	62·598	·931
5 feet.........	25·849	·950	35·947	·895	61·796	·919
10 feet.........	25·595	·944	35·217	·877	60·812	·904
20 feet........	25·064	·924	35·278	·878	60·342	·897

Elevation-gauges at Calne and their results.



Simultaneously with this series of elevation-gauges, another set were started by Colonel Ward, with a view of determining the relative indications of gauges of various sizes; they are not quite uniform in pattern, since so to make them would, it is believed, have entailed greater errors than by slightly varying the arrangements of the larger gauges, the main object being to give them greater stability and prevent their being blown away by gales of wind. The following Table shows the total amount registered by each gauge during the two years 1864–1865, and its difference from the mean of all these gauges:—

TABLE II.

Gauges all 1 foot above ground.

Size of gauge.	Total collected.	Difference from mean.
1 inch diameter	46·490	−2·900
2 inches "	47·964	−1·426
4 " "	49·717	+0·327
5 " "	49·720	+0·330
6 " "	50·809	+1·419
8 " "	51·166	+1·776
12 " "	49·808	+0·418
24 " "	49·576	+0·186
5 " square...	49·140	−0·250
10 " " ...	49·512	+0·122
Mean............	49·390	

From this it will be seen that (at a height of 1 foot) the extreme results are given by *very* small and by medium-sized gauges; that gauges 4 in., 5 in., 12. in., 24 in. diameter, and one 10 in. square, agree within considerably less than a half per cent.

But it must be understood that these results are not to be accepted as final, very much has yet to be done; they have to be varied in position and height, and other points looked to.

I have entered thus into detail respecting the Calne experiments, because they are the model of which two copies, with considerable variations, have since been started, one at Castleton Moor, Manchester, by the Rev. J. Chadwick Bates in 1863, and one at Rotherham, by Mr. Chrimes, erected during last month. Mr. Bates's set being mainly a duplicate of those at Calne, I propose to mention only two instruments at work there, viz. a thermo-rain-gauge constructed of ebonite (to avoid influencing the temperature of the rain by contact with metallic surfaces), and so arranged as to show moment by moment the temperature of each shower as it falls; there have been some considerable difficulties in getting it arranged, but now they are reported to be settled, and I look with some interest to comparing the results of Mr. Bates's set of elevation-gauges with his records of the temperature of the rain. Mr. Bates has also devoted a good deal of attention to the construction of a self-registering rain-gauge, but not having seen it, or a drawing of it, of course I can express no opinion on its merits.

The last set of experimental rain-gauges, and in some respects the most curious, are those erected by Mr. Chrimes on a very exposed plot of land near Rotherham. They consist of about twenty 5-inch gauges, the funnels of which are employed as follows:—two at 25 feet above the ground (one being for *daily* and one for monthly measurement), two at 20 feet, two at 15 feet, two at 10 feet, two at 5 feet, and, I believe, one or two on the ground.

There is also a gauge similar to one used by Professor Phillips some thirty years since on the top of York Minster, and constructed to show the angle and azimuth of every shower. It has five funnels (with separate receivers to each), the orifice of one being horizontal and of four vertical, one facing each of the cardinal points N., S., E., and W. Of course, unless rain falls absolutely vertically or horizontally and exactly from one of the cardinal points, it will enter more than one of the funnels, and the relative amount will enable us to ascertain the angle at which the rain has fallen. This, it is not improbable, will tend to explain the variation of rainfall with elevation above the ground, especially in conjunction with Mr. Chrimes's two other gauges, which are both made to revolve by vanes and kept face to wind; one of them has its funnel fixed at an angle of 45°, the other tips or tilts towards the wind, being provided with levers, carrying hemispherical cups (like anemometer cups), and provided with sundry counterpoises, so that in a perfect calm the orifice will be horizontal, and in a driving gale nearly vertical and facing the wind.

Before passing to other branches of rainfall matters, I should not omit to mention that the question of *material* has not been overlooked. Metal gauges, as every observer knows, soon become oxidized, and then a certain portion of every shower is held in the roughened surface of the funnel, and evaporates instead of being measured; on each separate occasion the loss is inappreciable, but when the gauge is heated (and all know how hot black metal gets in the full rays of the sun), and hot sunshine and warm showers frequently alternate, it will be seen that the error is rapidly multiplied, and must exert a sensible effect. Pressed as I have hitherto been by the variety of rainfall matters that brook no delay, this one has never received full consideration until I was writing this paper, but one plan now strikes me which, as a temporary measure, I submit to the opticians and to my observers, namely, *to paint their gauges white instead of black*, as they will thereby be many degrees cooler than they now are. Water is, however, apt to stand in blebs on fresh paint or japan, and *so* fails to pass inside the gauge. I therefore tried several materials, by far the best at present being ebonite, of which the whole gauge might I think be made, as well as the funnel I have now had at work for some years, and which is alike unchanged in surface or in figure (which is more than can be said for most metal gauges, since they generally warp more or less). I hope this year to get glass and earthenware funnels tried against the ebonite and metal ones.

4. *Various small matters desirable for determination.*—Into the details of these I will not here enter, suffice it to say that it includes among others turf-gauges, percolating gauges, isolated sunk gauges, the influence of river mists on the amount of rain collected, the determination of the amount of sea spray mingled with rain at exposed coast stations, &c.

5. *The steps that have been taken to secure accuracy and uniformity of practice among all the observers.*—These consist in small details, chiefly such as issuing suggestions as to the selection of a position for a rain-gauge, its management, the mode of keeping the register, the measurement of snow, the hour at which the observation is to be taken, and the day to which it is to be entered. On this last head it may be remembered there were a few remarks in the 'Proceedings' (p. 423) of this Society last spring. Circu-

lars were issued as there promised, and the replies of the observers (at least of several hundred of them) were forwarded to G. Pigott, Esq., of Abington Pigotts, who most kindly relieved me from the classification of them. The result may be very briefly told. More than half the observers observe at 9 A.M., and four-fifths observe between 8 and 10 A.M.; only twenty-nine observe at midnight, and seventeen at 9 P.M. It is therefore obvious that the minority of 18 per cent. (who moreover do not agree among themselves) should bow to the majority of 82 per cent., and make 9 A.M. their hour of observation. So much for the hour. The next question is, to which day is the fall to be entered; to that on which it falls, or that on which it is measured. Two reasons appeared so strongly in favour of the former course, that I was very glad to find the majority of the 82 per cent. did so record their fall. (1) The true end of the month being midnight on the last day, it is obvious that 9 A.M. on the last day is fifteen hours too soon, and 9 A.M. on the first day only nine hours too late, and that therefore 9 A.M. on the first day is more accurate than 9 A.M. of the last, as 15 is to 9, or 5 to 3. (2) By the adoption of 9 A.M. on the first, as the concluding observation of the previous month, and consequently entering the amount measured each morning to the previous day, the date of a rainfall will generally accord with the popular notion, that is to say, if it rains from 9 A.M. to 6 P.M., on say, the 8th, it will be measured on the 9th, but recorded to the day it fell.

Having communicated the result of this investigation to Mr. Glaisher, I received a reply from him agreeing to recommend *that 9 A.M. be adopted, and that the fall then measured be placed against the day preceding that on which it was measured*, but stipulating that when rain is known to fall between midnight and 9 A.M. of the first of any month, a note to that effect should be added in the register. It is satisfactory to add, that I believe this suggestion will be generally adopted, and when fresh forms have been supplied by the Meteorological Society, there will, I hope, be few departures from uniformity of practice.

6. The last head on which I have to speak before proceeding to the second branch of my subject, is *the amount of information collected*. I find on referring to the paper I read to this Society in 1863, that up to that time I had obtained and tabulated the monthly fall at about 900 stations, amounting in the gross to about 8000 years. I have not time now to take stock of my present stores, so must content myself with stating that, in August 1865,

[*To face page* 98.]

of years.

Year.	Mean yearly fall.	welve years.	Fifteen years.	Twenty years.	Twenty-five years.	Year.
1815.	27·12	28·37	28·74	28·76	28·80	1815.
1816.	29·26					1816.
1817.	29·73					1817.
1818.	30·34					1818.
1819.	30·46					1819.
1820.	24·53					1820.
1821.	29·92					1821.
1822.	26·63					1822.
1823.	31·09					1823.
1824.	30·91					1824.
1825.	26·57					1825.
1826.	23·76					1826.
1827.	29·53	29·04				1827.
1828.	33·02					1828.
1829.	28·70					1829.
1830.	30·83		28·42			1830.
1831.	32·28					1831.
1832.	26·20					1832.
1833.	29·71					1833.
1834.	24·52					1834.
1835.	28·56			28·45		1835.
1836.	33·49					1836.
1837.	24·54					1837.
1838.	27·11					1838.
1839.	31·27	28·59				1839.
1840.	24·67				27·60	1840.
1841.	33·51					1841.
1842.	25·53					1842.
1843.	30·40					1843.
1844.	23·72					1844.
1845.	27·87		27·49			1845.
1846.	29·57					1846.
1847.	25·80					1847.
1848.	35·98					1848.
1849.	28·51					1849.
1850.	26·35					1850.
1851.	26·70	27·42				1851.
1852.	35·53					1852.
1853.	27·38					1853.
1854.	22·38					1854.
1855.	23·37					1855.
1856.	25·89					1856.
1857.	25·70					1857.
1858.	22·79					1858.
1859.	28·53					1859.
1860.	33·34					1860.
1861.	26·98					1861.
1862.	30·37					1862.
1863.	26·93					1863.
1864.	22·11					1864.
1865.	28·82					1865.

the total number of stations was doubled, being not far short of 2000, and the number of complete yearly returns to about 12,000. It will hence be seen that the collection of old returns has not kept pace with the increase of stations; the explanation lies in the fact that I cannot be in two places at once, and that so long as the geographical distribution of existing stations was imperfect, I have felt bound to look to that, and to the collection of manuscript observations (which are always getting burned on the death of the observers), rather than to the printed returns which are safe in the British Museum Library.

FLUCTUATIONS IN THE ANNUAL FALL OF RAIN.

I have ever maintained, and still do so, that my first duty is to organize a complete system of rainfall-observation, and to collect all the records which can possibly be obtained, and then we shall have at once a firm and unimprovable basis for any deductions we may wish to draw. But I did not see that that should preclude my endeavouring to give some approximate results. Possibly some *few* may prefer to have nothing but what is perfect; but I know that the many would rather have an approximation than wait an indefinite number of years for absolute accuracy.

I make, therefore, no apology for submitting the following results of a temporary investigation made last spring, and partly published in 'The Times' and other papers—I say partly, because though the mean values for each of the fifty years were then published, the present mode of tabulating them is new.

A few of the more prominent results may be mentioned.

1. The mean of each ten years, from 1815 to 1854, is within half an inch of 28·64; moreover, the mean of the first thirty years, 1815 to 1844, is 28·60, and that of the ten years, 1845–54, is 28·61; therefore they may be taken as equal, and the latter ten years as representing the whole forty years, and the difference between them and the subsequent ten years, 1855–64, as a measure of the actual decrease during that period. Without entering into details, it may be broadly stated that this plan having been adopted, it was found that the decrease was greatest in the south and middle of England, especially along a line running N.E. from Cornwall to the Wash; north of this line the decrease is less, until on a parallel line running through the centre of Ireland and out into the sea by Edinburgh, there was an excess during the above-named years.

2. The mean of the ten years, 1850–59, is about 6 per cent. be-

TABLE IV. Rainfall in the three decennial periods 1830–39, 1840–49, 1850–59; also difference of each year since 1859 from the mean of 1850–59.

ENGLAND AND WALES.

Division.	Station.	County.	Mean.			Difference from mean 1850–59.					
			1830–39.	1840–49.	1850–59.	1860.	1861.	1862.	1863.	1864.	1865.
			in.	in.	in.	in.	in.	in.	in.	in.	in.
I.	Chiswick	Middlesex	24·06	23·83	22·59	+ 7·49	− 3·11	+ 3·95	− 2·27	− 5·73	+ 4·33
II.	Cobham	Surrey	24·06	24·16	22·41	9·16	1·64	3·85	1·90	4·63	6·76
	Chichester	Sussex	......	29·10	26·67	10·77	1·52	·80	1·59	3·42	9·01
	„ Shopwyke	„	......	......	26·25	11·26	2·47	·90	2·50	4·70	10·45
	„ West Dean	„	......	......	35·30	13·64	4·51	·81	1·17	7·82	9·37
	Ventnor	Hants	......	25·74	28·46	7·72	1·17	1·47	·90	6·59	4·27
III.	Hemelhempstead	Herts	......	25·86	26·43	7·79	5·23	+ 1·01	3·67	9·47	3·82
	Hitchin	„	......	......	24·72	5·56	4·80	− 2·20	5·37	7·56	5·54
	Oxford Observatory	Oxford	23·56	23·55	22·24	4·64	1·95	+ 1·15	3·99	7·39	1·66
	Banbury	„	......	......	24·73	7·19	2·39	2·78	3·58	4·51	3·56
	Althorp	Northampton	......	......	20·34	7·00	·94	3·87	3·37	3·13	5·16
	Cardington	Bedford	......	......	21·60	4·36	1·87	·57	2·89	4·19	5·65
IV.	Epping	Essex	25·84	26·99	23·18	13·85	2·76	2·68	3·93	8·38	3·76
	Witham	„	......	......	20·55	5·53	1·72	+ 1·23	3·22	5·15	4·44
	Norwich	Norfolk	......	......	26·08	8·39	1·28	− 2·03	7·50	8·29	+ ·43
	„ Honingham	„	......	......	25·99	7·07	·95	3·18	7·37	11·37	− ·44
	Burnham	„	......	......	26·86	7·79	2·08	·15	3·90	9·18	+ 2·27
	Holkham	„	......	......	26·13	+ 8·56	− 4·33	− 3·41	− 7·90	−11·63	+ ·55

V.	Baverstock	Wilts	……	31·09	28·69	+ 8·76	− 1·94	+ 1·61	+ 1·76	− 7·29	+ 2·41
	Goodamoor	Devon	……	55·48	54·13	17·89	·47	9·01	4·67	15·84	3·87
	Exeter Institution	„	28·92	29·35	26·91	9·17	1·11	2·67	4·53	4·29	8·56
	Clyst Hydon	„	……	……	30·74	10·78	5·53	·19	1·58	7·60	6·31
	Bradninch	„	……	……	34·71	11·89	2·51	3·99	1·39	6·81	7·09
	Broadhembury	„	……	35·14	32·75	9·87	− 4·23	4·02	+ 2·53	7·38	4·40
	Helston	Cornwall	……	……	36·22	6·74	+ 1·40	2·21	− ·26	7·66	8·52
	Bodmin	„	……	……	43·48	12·85	+ 1·08	3·88	1·13	6·35	5·50
	Swanswick	Somerset	……	25·62	25·20	3·44	− 1·86	1·32	1·64	8·32	·75
VI.	Cirencester	Gloucester	……	……	29·60	7·34	− 2·21	2·86	1·65	4·92	+ 6·22
	Burford	Shropshire	……	……	25·52	6·03	+ 1·20	5·58	1·12	6·22	− 1·07
	Haughton Hall	„	……	……	24·02	7·21	− ·22	1·68	2·81	6·79	− ·77
	Orleton	Worcester	……	28·41	28·82	8·07	+ ·99	+ 5·49	1·15	7·03	+ 1·06
VII.	Wigston	Leicester	……	……	26·39	5·08	− 3·19	− ·26	4·62	8·79	·41
	Welbeck	Notts	……	25·44	23·29	7·25	+ ·87	− ·52	3·74	·69	1·22
	Derby	Derby	……	……	23·98	8·79	− 1·97	+ 2·30	− ·38	2·24	+ ·48
VIII.	Bolton-le-Moors	Lancashire	……	46·46	44·01	13·65	+ ·90	9·42	+ 9·74	1·27	− 6·50
	Belmont	„	……	……	51·19	8·61	4·51	10·71	14·81	2·99	8·59
	Bufford	„	……	……	33·24	6·42	1·55	4·46	6·50	4·10	5·39
	Preston (H. of Corr.)	„	……	……	33·60	4·26	2·30	8·16	8·50	− 1·30	2·76
	„ Howick	„	……	……	34·28	5·48	2·31	10·05	7·59	+ ·13	2·73
	„ Fishwick	„	……	……	29·10	6·94	4·22	9·04	9·98	− 1·43	1·94
	Stonyhurst	„	……	……	45·37	5·23	3·63	9·03	12·69	− 3·57	4·78
	Holker	„	……	……	39·17	7·90	10·94	8·41	4·03	+ 4·39	− ·82
	Coniston	„	……	……	71·40	18·10	30·80	25·00	12·50	·50	+ ·70
	Wray Castle	„	……	……	60·81	8·64	20·10	13·91	7·53	+ ·25	− 5·90
IX.	Redmires	York	……	40·75	37·86	6·42	·08	2·20	2·84	− 5·98	5·39
	Standedge	„	……	……	49·57	7·18	+ ·18	+ 3·68	+10·93	+ 2·18	− 8·57
	Ackworth	„	……	……	22·84	6·56	− 4·58	− 1·01	− 1·75	− 3·09	+ ·37
	Halifax, Well Head	„	34·51	31·88	30·71	3·62	+ ·08	+ 1·51	+ 6·87	7·07	− 2·75
	Leeds (Holbeck)	„	……	……	20·91	7·69	2·39	+ ·34	+ ·54	4·26	− ·26
	„ (Manor Road)	„	……	……	23·31	3·88	+ ·02	− 1·52	− 2·69	6·27	+ 2·47
	„ (Eccup)	„	……	……	24·98	6·02	− ·73	+ 1·13	+ ·20	6·03	− 2·32
	Settle	„	……	43·41	35·55	6·23	+ 6·24	7·22	8·73	2·95	− ·17
	York	„	……	25·42	22·02	+ 8·35	− 1·75	+ 1·09	+ ·21	− ·89	+ 1·17

TABLE IV. (*continued*).

Division.	Station.	County.	Mean.			Difference from mean 1850–59.					
			1830–39.	1840–49.	1850–59.	1860.	1861.	1862.	1863.	1864.	1865.
			in.	in.	in.	in.	in.	in.	in.	in.	in.
X.	Bishopwearmonth......	Durham............	......	19·94	16·91	+ 7·80	+ 2·39	+ 4·06	+ 4·80	+ 2·61	+ 3·82
	Seathwaite...............	Cumberland	......	......	126·98	+15·22	55·60	43·05	46·86	+ 7·69	− 9·49
	Keswick.................	„	......	......	55·01	− ·84	19·41	6·36	16·53	− 2·33	− 5·83
	Kendal	Westmoreland ...	56·22	51·18	44·92	+12·08	15·78	9·49	10·00	+ 2·65	+ 2·25
	Troutbeck	„ ...	......	......	72·13	30·45	+44·13	+22·14	12·84	+ 3·61	− 8·08
XI.	Guernsey	Channel Isles ...	......	......	34·46	13·54	− 3·24	− 1·96	·34	− 1·80	+ 8·89
	Calf of Man	Isle of Man	24·45	24·65	24·86	12·49	+10·38	+17·63	3·01	+ ·21	− 2·57
	Point of Ayre	„	28·26	......	29·01	+ 6·83	+ 5·59	+ 2·72	+ 1·90	− ·89	− 1·86

SCOTLAND.

Division.	Station.	County.	1830–39.	1840–49.	1850–59.	1860.	1861.	1862.	1863.	1864.	1865.
XII.	Mull of Galloway......	Wigtown	......	20·67	22·52	+ 6·71	+ 4·32	+ 2·92	+ 4·35	+11·55	+ 4·89
XIII.	Haddington	Haddington	......	23·77	24·34	2·96	+ 1·56	5·46	− 1·34	3·76	+ 3·16
	Thurston	„	......	27·04	26·96	+ 7·14	− 1·16	3·44	− 1·16	+ 9·04	− 1·36
	Glencorse	Edinburgh.........	......	......	36·96	− 7·26	+ 1·14	6·14	+ 2·34	− 1·16	− 2·36
	Inveresk..................	„	......	25·81	24·72	+ 7·25	+ 3·79	8·17	4·38	+ 5·30	+ 3·06
XIV.	Bothwell Castle.........	Lanark	......	......	27·76	− 1·74	− 2·32	11·20	2·56	− 2·20	− 4·06
	Mansfield	Ayr..................	......	......	43·06	+ 1·54	+12·74	11·64	11·04	− ·26	3·26
	Brisbane..................	„	......	......	46·85	1·60	15·15	12·85	8·75	+ 2·05	2·05
XV.	Pladda	Bute	......	40·02	35·23	3·15	+ 7·61	18·46	8·11	−11·70	− 8·28
	Mull of Cantyre	Argyll..............	......	45·76	41·19	+ 7·85	− ·71	2·03	2·36	2·69	+11·67
	Rhinns of Islay.........	„	34·07	33·79	30·58	− ·07	+ 3·76	3·89	4·53	3·41	+ 3·77
	Castle Toward	„	51·55	......	47·88	− ·70	17·46	14·39	9·38	− 1·03	− 3·99
	Lismore..................	„	......	......	38·44	+ 3·14	6·93	9·95	15·68	+13·68	+ 1·67
	Ardnamurchan	„	......	......	38·50	1·28	15·42	14·54	15·43	7·67	2·28
	Hynish (I. of Tiree)...	„	......	......	73·90	+14·33	+15·67	+14·08	+13·79	+ 4·52	+ 2·80

XVI.	Isle of May	Fife..................	21·96	20·94	15·21	+ 6·61	+ 7·19	+ 9·87	+ 3·40	+ 7·55	+ ·60
	Deanston	Perth	......	35·74	39·21	− 1·91	5·84	12·34	+ 5·34	+ 2·69	− 5·46
	Stanley	"	......	32·00	29·05	+ 2·06	5·53	5·02	− 1·30	− ·45	− 1·59
	Craigton	Forfar	......	......	31·87	5·70	3·06	6·37	3·02	+ 8·95	+ 1·55
	Hill Head	"	......	......	31·06	6·37	4·49	6·27	2·66	9·78	2·90
	Seichen	"	......	......	32·07	6·73	4·81	6·39	− 1·86	11·01	+ 1·65
XVII.	Girdleness	Kincardine.........	......	23·14	19·71	2·64	2·77	+ 5·83	+ ·43	2·93	− ·09
	Castle Newve............	Aberdeen	......	......	32·98	7·51	6·08	− 3·57	− 4·19	+ 3·50	+ ·37
	Buchanness	"	26·40	26·84	23·40	+ 2·64	1·29	− ·96	− 4·47	− ·97	− 2·88
	Kinnaird Head	"	19·66	22·01	22·04	− 6·74	1·59	+ 2·98	+ 4·89	+ 5·18	·21
XVIII.	Cromarty	East Ross	......	......	23·66	+12·20	17·47	− 3·30	+ 2·97	− ·34	− 4·15
	Barrahead	West Inverness...	......	31·60	32·67	− 4·23	·99	+ 1·98	− 5·94	+ 4·10	+ 2·77
	Island Glass	" " ...	33·23	34·98	31·92	6·88	1·71	− 6·78	− 8·02	−14·41	−13·99
XIX.	Cape Wrath	Sutherland.........	......	38·86	36·94	− 1·86	3·32	+ 3·32	+14·01	+ 1·25	4·14
	Noss Head..............	Caithness	......	......	25·57	+ 1·66	1·24	− 4·53	− 1·58	1·66	10·48
	Dunnet Head...........	"	......	27·39	22·09	3·53	8·05	+ 3·02	+ 2·33	6·36	− ·24
	Pentland Skerries	"	26·48	......	24·12	2·25	8·39	+ 5·11	3·28	+ 7·82	+ 1·93
	Sandwick	Orkney	......	......	36·14	+ 1·82	5·04	− 1·76	3·58	− 2·86	− 1·93
	Start Point	"	27·39	25·05	23·77	− ·76	5·53	+ 1·77	1·52	+ 1·15	4·94
	Sumburghead	Shetland...........	......	25·43	25·22	+ ·78	4·21	2·40	·39	− 1·32	4·75
	Bressay	"	......	......	36·22	+ ·58	+ 4·93	+ 9·73	+ 7·18	+ 6·78	− 4·12

IRELAND.

XX.	Portlaw	Waterford	......	......	39·49	+ 7·22	+ 9·82	+10·61	+ 2·25	+ 0·78	+ 7·76
	Killaloe	Clare	......	......	38·33	10·43	13·51	9·04	12·20	− 2·69	7·71
XXI.	Black Rock	Dublin	......	23·20	21·78	4·92	2·89	3·20	1·29	+ 3·95	8·02
XXIII.	Armagh	Armagh	......	34·80	33·92	2·43	9·28	8·13	5·08	+ ·80	4·01
	Belfast	Antrim	......	29·44	30·01	+ 9·83	+ 7·40	+11·17	+ 8·54	− ·08	+ 5·77

low the other forty years, thereby closely agreeing with what I stated in my last paper to this Society, "This mean (1850–59) is about 5 per cent. too low." Thus the present Table is incidentally confirmed, and shown to be more accurate than I should have expected from the irregular distribution of the ten stations on which it is based.

3. Omit the years 1854–58, and the five-year means never vary an inch.

4. In the first ten years, seven were above the average; in the second, six were above, then five, then four, and in the last only three.

5. It is worth noting that the wettest years have run in *twelve*-year periods; 1860, 1848, and 1836 had a mean of 34·27, which is *higher* than any other individual year except 1852. The dry years, on the other hand, seem to run in *ten*-year periods; 1864, 1854, 1844, and 1834 had a mean of 23·18, which is *lower* than any other individual year except 1858. It will be seen that 1824 is common to both series, and has therefore been omitted; as might have been expected, it was near the average.

6. The wettest year (1848) had a mean of 35·98 inches; the two wettest consecutive years (1848 and 1849) of 33·25; the three wettest consecutive years (1828, 1829, and 1830) of 30·85.

7. The driest year (1864) had a mean of 22·11; the two driest consecutive years (1854 and 1855) 22·88; the three driest consecutive years (1854, 1855, and 1856) 23·88.

8. Therefore if a large tract of country be taken together, the fluctuation seems to be limited to about a fourth of the mean total, being in this instance 28 per cent. in excess in the wettest year, and 22 per cent. in defect in the driest. It can hardly be necessary to state that this is considerably less than occurs at individual stations, where the maximum is not unfrequently *twice* the minimum, sometimes more, *e. g.*, Exeter Institution, 1852, =42·62; 1854=18·12; Chiswick, 1852=32·53; 1858=15·78; Edinburgh, 1830=33·25; 1826=15·27.

It will be interesting and useful to check Table III. by the means given in Table IV.; the result is as under.

(1) From stations complete for the thirty years, 1830–59.

	Depth.			Ratio.		
	1830–39.	1840–49.	1850–59.	1830–39.	1840–49.	1850–59.
Eight English stations	30·20	29·45	27·23	103	102	95
Six Scotch stations	27·12	27·27	24·49	103	104	93
Fourteen British stations..	28·66	28·36	25·86	103	103	94
Average, from Table III. ...	28·85	28·56	26·47	104	102	94

(2) From stations complete for the twenty years, 1840–59.

	Depth.		Ratio.	
	1840–49.	1850–59.	1840–49.	1850–59.
Twenty-two English stations	31·52	29·48	103	97
Nineteen Scotch stations	29·52	27·72	103	97
Forty-one British stations...	30·52	28·60	103	97
Average, from Table III. ...	28·56	26·47	104	96
The four Irish stations	29·15	28·57	101	99

(3) Of course Table III. may be further checked by each year since 1859, but I have not the time requisite for so doing; moreover, there will be some difficulty with the enormous excesses in the mountain districts (often more than 20 inches per annum), and which therefore conceal the real fluctuations of the fall in other districts.

I proceed, lastly, to a few notes on Table IV.

The first glance shows that—

1860 was a wet year everywhere but in the N.W. of Scotland.

1861 was wet in Scotland, Ireland, and the N.W. and W. of England; other parts of England were mostly dry.

1862 was wet in the greater part of England, dry in Norfolk, wet in Scotland and Ireland.

1863, dry in the central, eastern, and south-eastern counties of England, also in the east of Scotland; wet elsewhere.

1864, remarkably dry in England, except at a few stations in the north-western counties. In Scotland, however, there were many stations with considerably more than their average fall (especially in Argyll and Forfarshire); Ireland was near the average.

1865. All English stations, save those in the north-western counties, had more than their average. In Scotland it was near the average, and in Ireland decidedly wet.

Therefore we find the last six years include two remarkable years—1860, which was one of the wettest years this century, the only wetter ones being 1836=33·49, 1841=33·51, 1848=35·98, 1852=35·53, 1860=33·34; and a very dry one, 1864; in fact the driest one for fifty years. Its severity was more felt, because in many places it followed one or more dry years; in Norfolk every year, from 1861 to 1864 both inclusive, was considerably below the average, and 1864 the driest of them all, hence the scarcity of water was severely felt; the same occurred in Leicestershire and in Nottinghamshire.

On the other hand, a semi-deluge seemed to threaten the west of Scotland, where, in 1861, 1862, and 1863, excesses of 30 per cent. were frequent year after year; they ceased, however, in 1864 and the fall resumed its ordinary averages.

ERRATA.

Report for the year 1857, *Mr. Glaisher's paper on Mean Temperature.*

TABLE I.	January	14, 1815,	*for*	16°·2	*read*	39°·6
	„	30, 1831,	„	33·8	„	26·2
	„	29, 1832,	„	30·2	„	40·2
	„	19, 1833,	„	43·5	„	33·5
	„	1, 1837,	„	39·5	„	29·5
	„	16, 1837,	„	39·9	„	34·9
III.	March	31, 1819,	„	43·6	„	53·6
	„	10, 1820,	„	23·9	„	33·9
	„	15, 1822,	„	52·9	„	42·9
	„	5, 1827,	„	31·5	„	41·5
IV.	April	13, 1815,	„	33·2	„	53·2
	„	6, 1833,	„	54·7	„	44·7
V.	May	5, 1814,	„	48·4	„	38·4
	„	28, 1824,	„	66·1	„	61·1
	„	3, 1832,	„	36·2	„	50·0
	„	28, 1833,	„	44·5	„	59·5
VI.	June	19, 1819,	„	65·8	„	59·0
	„	13, 1823,	„	51·2	„	61·2
	„	5, 1825,	„	57·1	„	47·1
	„	17, 1832,	„	46·6	„	64·6
IX.	September	12, 1814,	„	59·8	„	49·8
X.	October	12, 1819,	„	53·2	„	58·2
	„	28, 1831,	„	59·9	„	49·9
XI.	November	4, 1832,	„	52·0	„	42·0
XII.	December	10, 1832,	„	35·3	„	45·3
	„	22, 1833,	„	31·9	„	41·9

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Page 5, paper CVIII., for *On* (the first word on the title) read *Translation from.*

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This Society was established in the year 1850, for the encouragement and promotion of Meteorological Science, and incorporated by Royal Charter in 1866.

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Candidates may be proposed at a Council

THE METEOROLOGICAL SOCIETY.

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---

to Mr. Glaisher, by whom each reading is examined and collated with readings made in adjacent stations, their means taken or examined, and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of Mr. Glaisher's 'Quarterly Meteorological Report' *is sent free to every Fellow of the Society.*

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1866, March 1.

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Vol. III. 1866, MARCH 21. [No. 24.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Franklin G. Evans, Esq., Tynant, Pentyrch, Cardiff;
Thomas H. Morgan, Esq., Ore, Hastings;
Fenwick William Stow, Esq., M.A., Charterhouse, E.C.;
were balloted for and duly elected Fellows of the Society.

The names of Ten Candidates for admission into the Society were read.

CXVII. *Researches on the Distribution of Temperature on the Surface of Switzerland during the Winter of* 1863–64. By Professor E. Plantamour. Translated from the paper read before la Société Helvétique des Sciences Naturelles at its Meeting in Zurich, August 23, 1864. By James Glaisher, Esq., F.R.S.

By means of the publication of the first three pamphlets of meteorological observations made in Switzerland*, the utility and importance of the observations collected in our country by the establishment of a system which includes a considerable number of stations in a space comparatively restricted, are already becoming appreciated. In consequence of the country being so mountainous in Switzerland, these observations contain valuable materials for the study of the general phenomena of meteorology and climatology, and at the same time also for special, that is to say, local knowledge of the different parts of the country respecting climate and physical geography. These pamphlets contain the record of the temperature, taken at three times during the day, for the first three months, in nearly eighty stations. These observations can well admit of comparison, since the hours are the same for all stations; the thermometers have been constructed by the same maker, Monsieur Geissler, of Bonn, according to one uniform type, and the same situations and the same precautions have been employed in the disposal of these instruments. Thus these observations offer the means of studying the distribution of temperature on the surface of a country, the habitable and inhabited parts of which are at altitudes possessing a range of 2200 metres, or 7218 feet, and of comparing the results that are found for stations situated at an elevated and little varying plain, according as they are placed on a plateau, an isolated peak, on the top or on the side of a mountain, or in the depths of a valley lying between two high mountain-chains. Last winter was the more favourable for this study, because during part of the time it was unusually severe throughout the whole of Central and Western Europe; it is, in fact, in such cases that the influence of local circumstances is much more evident, either in increasing or decreasing the cold.

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* These observations are printed at Zurich; they are published monthly, in a quarto pamphlet of six or seven leaves.

The particular end that I have proposed to myself in this work is the comparison, in all the Swiss stations, of the mean temperature for the months of December 1863, January and February 1864, as well as the extent of diurnal range; thus I wished to be able to find the law or formula by which the temperatures of all the stations could be united, and consequently the local influence manifested in any point whatever by the deviation from the law or formula. I have taken for the mean temperature of a month, the arithmetical mean of three daily observations taken at 7^h in the morning, 1^h in the afternoon, and at 9^h in the evening; this mean, is not, it is true, strictly equal to that of the twenty-four hours, but it differs very little from it, and during these three months the deviation has been found so little different in three points placed in very different circumstances, that a correction may be neglected, which would have evidently been the same for all stations and numerically very small. I have found in fact from the three stations, Geneva, Simplon, and St. Bernard, where the system of bi-horal observations enables us to determine with great exactitude the diurnal variation of temperature and the mean of the twenty-four hours, that it is necessary to apply to the arithmetical mean of 7^h, 1^h, and 9^h, the following corrections, in order to obtain the exact temperature of the twenty-four hours:—

	December 1863.	January 1864.	February 1864.
	°	°	°
Near Geneva	−0·37	−0·37	−0·15
Near Simplon	−0·29	−0·56	−0·58
Near St. Bernard	−0·27	−0·49	−0·41

I have taken for a measure of the extent of the diurnal range the difference between the temperature observed at 1 o'clock in the afternoon and at 7 o'clock in the morning; this difference is, it is true, smaller than the real range, inasmuch as in this season the hour of 7^h in the morning is approaching the minimum, and that of 1^h the maximum. Nevertheless this difference can be used for comparing the stations one with another with regard to the daily range, even when the hour of the minimum should be advanced, and that of the maximum retarded as occurs in summer.

The mean temperature of a locality during a given space of time depends on general circumstances, whose influence can be explained by a law and translated into figures by a formula, on knowing the altitude, longitude, and latitude; and on local circumstances whose influence cannot be represented by a formula. The figure expressing the value of the influence due to local circumstances cannot consequently be calculated and determined *à priori*, it depends *à posteriori* upon the comparison between the temperature observed and the temperature calculated by the formula which keeps account of general circumstances. Again, the numerical value of the coefficients, or the constants which enter in the formula, cannot be determined *à priori*; it must be calculated in each case by means of the temperatures observed in the different stations; and as the figures furnished by observation include the influence of local circumstances, these being able to act sometimes in one manner, sometimes in another, it is of consequence to multiply as much as possible the number of stations, and to choose them in circumstances as varied as possible, so that their effect might be counterbalanced and eliminated in the result.

It was evident on the first inspection of the Tables, that it was impossible to combine and to unite in one system of equation the observations furnished by the stations south of the Alps, with those situated in the interior of the chain and on the north. This powerful barrier exercises, in fact, such an influence upon the two opposite sides that, to express the action of the latitude in the passage from one to the other, a discontinuous function must be employed. I have consequently put on one side in the calculation of the formulæ the seven stations of Tessin and of Grisons, which are south of the Alps, afterwards I have endeavoured, by comparison with the temperature which would be assigned to them by the formulæ, to estimate the excess of heat that they owe to their position.

The sixty-nine stations, the observations of which I have had entered in the calculation, are distributed as to height between the limits of 275 metres, or 905 feet (Bâle), and 2478 metres, or 8130 feet (St. Bernard), thus giving a difference of 2200 metres, or 7218 feet; as to longitude, between the limits of $0^h\ 15^m$ (Geneva), and $0^h\ 32^m$ (Remüs dans les Grisons) East of Paris, thus giving a difference of 4¼° in longitude; then as to latitude, between the limits of 45° 52′ (St. Bernard) and of 47° 45′ (Lohn in the canton of Schaffhouse), which makes a little less than 2°. These limits as to longitude and latitude are sufficiently accurate to permit those changes of temperature to be seen which are due to geographical position, as being proportionate to the difference of longitude and latitude; if, then, we take as the starting-point the most central part of Switzerland, that is to say, that which corresponds to $0^h\ 24^m$, longitude East of Paris, and 46° 50′ latitude, we can express by

$$u(\mathrm{L}-0^h\,24^m) \quad \text{and} \quad v\left(\frac{\varphi-46^\circ\,50'}{6'}\right)$$

the change of temperature which will take place for a point whose longitude is L and latitude φ; u and v being the coefficients which represent the variation of temperature, in proportion as we advance one minute of time towards the east, and one-tenth of a degree towards the north.

As to the variation of temperature with height, it was not possible to admit the decrease simply proportionate to the height, considering the very remote limits between which the altitudes of our stations are included; even a superficial examination of the results given in the published Tables shows that this hypothesis is not admissible, and that it is not conformable to the facts observed. The most simple means of representing the decrease of temperature, in the limits of height which are met with in our stations, was to have recourse to an empirical formula, containing a succession of terms proportionate to the different powers of the difference of height. After many trials and much uncertainty, I became assured that it was not sufficient to take the term proportionate to the square, but that in adding a term proportionate to the cube, we should be enabled to represent, with tolerable exactness, the decrease observed. If for height we take as a starting-point the altitude of 1400 metres, which is nearly at an equal distance from the limits indicated above, the change of temperature which will take place for a point whose altitude is H, might be represented by

$$x\left(\frac{\mathrm{H}-1400}{300}\right)+y\left(\frac{\mathrm{H}-1400}{300}\right)^2+z\left(\frac{\mathrm{H}-1400}{300}\right)^3,$$

or more simply, in designating $\frac{\mathrm{H}-1400}{300}$ by h,

$$xh+yh^2+zh^3,$$

x, y, z representing the value of each of one of these terms for $h=+1$. Let then T be the temperature of a place situated at 1400 metres in height, $0^h\ 24^m$ longitude east, and 46° 50′ latitude, the temperature t of any place whatever in making allowance for the local influences by the formula will be

$$t=\mathrm{T}+xh+yh^2+zh^3+u(\mathrm{L}-0^h\ 24^m+v\left(\frac{\varphi-46^\circ\ 50'}{6}\right),$$

which includes the six unknown quantities T, x, y, z, u, v.

Each station, of which the temperature has been observed during a month, furnishes a numerical equation for the determination of the values of the unknown quantities for this month; by putting for t, H, L and φ the numbers which relate to this station, I had thus for each month sixty-nine equations, the solution of which by the method of the least squares should give the most probable values of the unknown quantities, that is to say, those which represent the temperatures observed in reducing to a minimum the sum of the squares of the errors, these last being attributed to local circumstances. To abridge a calculation which would have been exceedingly long, yet without affecting in any manner the correctness of the results, I have formed, according to the method employed in astronomical questions, some normal places, so to speak, by collecting in one single group a certain number of stations, the altitudes of which were little different, maximum 200 metres (656 feet) to 250 metres (820 feet); and most frequently below, and equally little distant in longitude and latitude. This group would supply only one equation, in which the values of *t*, H, and φ were the arithmetical mean corresponding values for all the stations thus collected. The number of groups thus formed was twenty, of which I reproduce the results in the following Table; it was useless to repeat here the figure of the temperature observed in each station, since it may be found in the meteorological pamphlets already published.

Groups.	Number of stations.	H.	L.	ϕ.	Mean temperature *t*.		
					December 1863.	January 1864.	February 1864.
		feet.	h m s	° ′	°	°	°
I.	5	1385	0 17 6	46 17	35·0	25·8	33·4
II.	9	1335	21 7	47 16	35·1	22·3	31·1
III.	8	1473	26 1	47 20	35·0	21·0	30·5
IV.	4	2241	19 5	46 34	31·6	21·3	30·2
V.	3	2162	21 0	47 14	32·5	20·6	30·2
VI.	3	2192	28 0	46 45	29·7	17·5	29·8
VII.	6	1929	27 5	47 11	33·8	20·6	31·6
VIII.	5	2989	26 2	47 7	31·1	21·2	28·5
IX.	5	3543	18 2	46 50	30·9	22·3	27·3
X.	3	3996	30 3	46 50	28·6	20·7	27·5
XI.	1	4213	21 0	47 15	28·0	22·6	25·6
XII.	3	4557	25 0	46 36	25·7	17·5	24·5
XIII.	2	4836	29 5	46 39	24·0	12·8	22·1
XIV.	2	5325	22 0	46 9	26·7	22·0	23·7
XV.	3	5794	30 0	46 30	23·3	12·7	19·4
XVI.	1	5853	25 0	47 3	27·1	23·3	22·5
XVII.	2	6368	23 5	46 25	24·7	18·3	19·6
XVIII.	2	6828	26 0	46 32	23·7	17·8	18·6
XIX.	1	7362	30 0	46 28	19·9	13·1	16·4
XX.	1	8130	19 0	45 52	21·7	16·4	14·6

The solution by the method of least squares of the twenty equations of condition, formed by the assistance of these results, has led me to the following formulæ, which show the distribution of temperature on the surface of Switzerland during each of the three months of last winter:—

December 1863: $$t = -2^\circ{\cdot}718 - 0^\circ{\cdot}901h + 0{\cdot}053\,.\,5h^2 - 0{\cdot}014h^3 - 0^\circ{\cdot}113(\mathrm{L} - 0^\mathrm{h}\,24^\mathrm{m}) + 0^\circ{\cdot}063\left(\frac{\varphi - 46^\circ\,50'}{6}\right);$$

January 1864: $$t = -6^\circ{\cdot}900 - 0^\circ{\cdot}268h - 0{\cdot}059\,.\,3h^2 - 0{\cdot}021\,.\,7h^3 - 0^\circ{\cdot}291(\mathrm{L} - 0^\mathrm{h}\,24^\mathrm{m}) + 0^\circ{\cdot}043\left(\frac{\varphi - 46^\circ\,50'}{6}\right);$$

February 1864: $$t = -4^\circ{\cdot}215 - 1^\circ{\cdot}633h - 0{\cdot}057\,.\,2h^2 + 0{\cdot}016\,.\,6h - 0^\circ{\cdot}020(\mathrm{L} - 0^\mathrm{h}\,24^\mathrm{m}) - 0^\circ{\cdot}058\left(\frac{\varphi - 46^\circ\,50'}{6}\right);$$

in terms of the Centigrade scale.

These formulæ show the mean temperature of each group, with an approximation as large as could be expected; in fact, in making the sum of the squares of the errors obtained by the substitution of the value of the unknown quantities for the equation of condition, we obtain,

			Fahr.		Fahr.
In December	1863,	mean error	±1°·1,	probable error	±0°·7
In January	1864	„	±1°·8	„	±1°·3
In February	„	„	±0°·8	„	±0°·5

The considerably higher amount of the deviation in the month of January is explained by the influence that local circumstances exercise in a high degree, in modifying the temperature, when it is as unusual as in this month.

The decrease of temperature with height may be made still more evident by calculating by means of formulæ the temperature at each 100 metres; and by supposing these two last terms insensible, the figures found for the temperature thus apply to the vertical above the spot, whose longitude is $0^\mathrm{h}\,24^\mathrm{m}$ and latitude 46° 50′.

Thus is obtained—

Height.	December 1863.		January 1864.		February 1864.	
	Temperature.	Difference.	Temperature.	Difference.	Temperature.	Difference.
feet.	°	°	°	°	°	°
656	36·8	−1·2	22·3	−0·5	32·6	−0·3
984	35·6	1·1	21·8	0·4	32·3	0·3
1312	34·5	1·0	21·4	0·3	32·0	0·5
1640	33·5	0·9	21·1	0·2	31·5	0·5
1968	32·6	0·9	20·9	0·3	31·0	0·7
2297	31·7	0·8	20·6	0·2	30·3	0·7
2625	30·9	0·7	20·4	0·1	29·6	0·7
2953	30·2	0·7	20·3	0·2	28·9	0·8
3281	29·5	0·7	20·1	0·1	28·1	0·9
3609	28·8	0·6	20·0	0·1	27·2	0·9
3937	28·2	0·6	19·9	0·2	26·3	0·9
4265	27·6	0·5	19·7	0·1	25·4	1·0
4593	27·1	0·5	19·6	0·2	24·4	1·0
4921	26·6	0·5	19·4	0·2	23·4	1·0
5249	26·1	0·5	19·2	0·2	22·4	1·0
5578	25·6	0·5	19·0	0·3	21·4	1·0
5906	25·1	0·5	18·7	0·4	20·4	1·0
6234	24·6	0·6	18·3	0·4	19·4	1·0
6562	24·0	0·5	17·9	0·5	18·4	1·0
6890	23·5	0·5	17·4	0·6	17·4	1·0
7218	23·0	0·6	16·8	0·7	16·4	0·9
7546	22·4	0·6	16·1	0·8	15·5	0·9
7874	21·8	−0·6	15·3	−0·8	14·6	−0·9
8202	21·2		14·5		13·7	

The law of the decrease of temperature with height therefore differs very much from one month to another, as is plainly shown in the Plate annexed to this memoir, which represents by curves the decrease with height during the three months. In the month of December the decrease diminished to the height of about 1800 metres (or 5906 feet); in the month of February, on the contrary, the decrease has followed an increasing progression up to this height, then it has diminished. In the month of January the decrease, which was very small in the first 100 metres, still diminished up to the height of 1100 metres to 1200 metres, when it was almost nothing and the temperature stationary, then it became more rapid at greater heights.

It is easy to see that an anomaly so marked as the month of January presents in the decrease of temperature is almost entirely due to the exceptional cold of the lower regions, and not to unusual heat in the higher regions; for the month of January has been nearly 8° colder than is usual at Geneva, whilst it has been only six-tenths warmer at St. Bernard. It must then be admitted that the lower parts of Switzerland, as well as a considerable part of the centre of Europe, have been invaded by a layer or sheet of cold air, which did not extend to any considerable height, at least not in a uniform manner; in fact, we find upon all the elevated summits of our field of observation, such as St. Bernard, Simplon, St. Gothard, Bernardin, Julier, Grimsel, Righi, and even Weissenstein and Chaumont, the cold exceedingly severe in the first days of January; in these localities it has not continued, but has been replaced by a temperature comparatively mild, as if the cold air descending from the higher regions, the limit of this, had gradually lowered itself in such a manner as only to cover again the least elevated regions. We find, again, a trace of this anomaly in the month of February, in the very slow decrease of the temperature in the lower strata; from 200 to 600 metres, the decrease of the temperature is less than a degree; it would thus appear that the sheet of cold air has gradually diminished in thickness, so as to cover no more, at this time, than the least elevated points from 700 to 800 metres.

As to the variation of temperature which results from a change in the geographical position, we see by the sign of the coefficient that the temperature declines in proportion as we advance towards the east, which agrees with the law confirmed in general in this part of Europe during the months of winter.

The decline is of
0°·8 Fahr. for an increase of 1° in east longitude in December.
2°·1 „ „ „ „ January.
0°·1 „ „ „ „ February.

In the side of the meridian is found an increase in the temperature of 1°·1 Fahr. in December, and of 0°·8 in January, in proportion as one advances 1° in latitude towards the north, and a decrease of 1° in February. This anomaly of an increase of temperature for a higher latitude in the first two months, as well as the very rapid decline for a more eastern longitude in the same two months, can be explained by the position and direction of the large mass of the Alps. As this large mass occupies the southern part, particularly in western Switzerland, the northern stations are in general more distant, principally those which are in the western region; consequently the effect which ought, without doubt, to be exercised by the Alps in decreasing the temperature of the neighbouring countries, ought to diminish with distance; it will consequently be less in the north, and more particularly in the north-west of Switzerland than in the other regions. The month of February presents a different result; the change with the longitude is almost nothing, and the temperature decreases more than ½° for an increase of 1° in latitude; it is very probable that the explanation of it would be found in the distribution of the temperature in Central Europe, and in the position of the pole relative to cold at this period. It is scarcely necessary to add, that these assumed formulæ cannot be employed to calculate the temperature of places situated beyond the limits of the field of observation, either horizontally or vertically, particularly if the distance be rather considerable.

It remains now for us to examine the influences that local circumstances exercise in modifying the temperature; this influence springs from the comparison between the temperature observed at a station and that which is assigned to it by a formula, which, according to all the other stations of the system, takes into consideration all general circumstances, such as height, longitude, and latitude. I give in the following Table for each station, of which I indicate at first the three coordinates, the difference between the temperature observed and the temperature calculated by the formula, for the three months, then for the entire winter. This difference expresses the influence of local circumstances in raising the temperature, if the sign is positive, in decreasing it if it is negative. The following columns give for each month the mean extent of the diurnal range, measured by the difference of 1^h in the afternoon and that of 7^h in the morning; we can, in fact, find in a great number of cases curious resemblances between the amount of the diurnal extent and the local anomaly of the temperature. The stations are arranged in the Table in the order of increasing altitude.

Reference No.	Station.	Altitude, H.	Longitude, L.	Latitude, φ.	Differences between the observed and calculated Temperatures.				Diurnal range of Temperature.		
					December 1863.	January 1864.	February 1864.	Winter 1863–64.	December 1863.	January 1864.	February. 1864.
		feet	h m	° ′	°	°	°	°	°	°	°
1	Bâle	902	0 21	47 33	+0·2	0·0	+1·7	+0·6	4·1	6·2	7·6
2	Zurzach	1165	24	47 35	−0·7	−0·9	0·0	−0·5	5·1	8·4	12·8
3	Morges	1247	17	46 30	+0·3	+1·1	0·0	+0·5	6·1	5·9	10·0
4	Montreux	1263	18	46 26	+2·4	+5·2	+2·4	+3·3	8·2	8·0	9·0
5	Aarau............	1276	23	47 23	−0·8	−0·8	−0·3	−0·6	4·8	7·5	12·1
6	Olten	1289	22	47 21	0·5	0·9	0·3	0·6	3·8	5·0	10·3
7	Schaffhouse ...	1306	25	47 42	0·3	−1·3	0·1	−0·6	3·4	6·7	10·0
8	Geneva	1339	15	46 12	−0·2	+0·8	0·1	+0·2	7·1	7·0	9·8
9	Zug..............	1375	25	47 10	+1·7	+1·4	−0·1	+1·0	3·8	4·8	10·8
10	Porrentruy ...	1411	19	47 25	0·0	−3·3	+0·4	−1·0	6·5	15·6	12·5
11	Kreutzlingen...	1411	27	47 39	+1·1	+1·0	−2·8	−0·2	3·0	3·7	8·0
12	Bex..............	1434	19	46 15	−0·5	0·9	+0·6	+0·3	11·2	17·2	15·4
13	Lucerne	1444	24	47 5	+0·4	+0·5	−1·3	−0·1	6·6	8·8	16·5
14	Soleure	1447	21	47 13	−1·2	−2·2	1·1	1·5	4·4	5·1	10·9
15	Winterthur ...	1473	26	47 30	+0·4	−0·0	−0·8	−0·1	4·8	7·5	11·9
16	Altdorf	1490	25	46 53	+1·9	+3·0	+1·8	+2·2	6·0	1·8	10·4
17	Stanz	1496	24	46 57	−0·2	+1·9	−3·3	−0·5	4·8	6·0	12·1
18	Alstätten	1555	29	47 23	+0·8	−0·5	1·2	−0·3	4·9	6·6	8·0
19	Zürich	1575	25	47 23	+1·0	+0·7	−0·1	+0·5	3·5	4·6	10·1
20	Neuchâtel	1601	18	47 0	−0·1	−1·2	+0·6	−0·2	4·5	4·6	9·3
21	Glaris............	1601	27	47 3	0·1	0·7	−1·0	0·6	6·4	10·4	11·5
22	Martigny	1634	19	46 6	−2·2	−0·8	+1·0	−0·7	4·5	9·6	11·6
23	Sargans	1654	29	47 3	+2·2	+0·2	1·6	+1·3	3·6	5·9	7·3
24	Marschlins......	1795	29	46 57	0·7	−0·2	+1·1	0·5	7·1	8·1	10·4
25	Schwytz	1795	25	47 1	+1·2	+3·3	−0·2	+1·4	4·2	4·0	6·2
26	Bötzberg	1873	23	47 30	−0·7	−2·4	+0·1	−1·0	3·6	5·3	9·9
27	Berne............	1883	21	46 57	−1·3	2·9	−0·6	1·6	6·4	10·6	13·9
28	Dizy	1929	17	46 38	+0·2	−0·7	+0·2	−0·1	5·7	5·7	9·7
29	Reichenau	1959	28	46 49	0·6	+2·4	1·2	+1·4	7·5	10·2	10·9
30	Coire	1978	29	46 51	+2·2	+4·0	+3·8	+3·3	5·1	6·6	9·6
31	Fribourg	2067	20	46 48	−0·6	−2·6	−1·0	−1·4	5·4	6·8	9·7
32	Lohn	2116	25	47 45	−0·8	−2·1	+0·5	−0·8	3·1	6·7	8·2
33	St. Gall	2244	28	47 26	+2·5	+1·9	0·0	+1·5	4·4	5·3	7·5
34	Gliss	2257	22	46 17	−2·5	0·3	+0·6	−0·5	4·5	7·0	9·6
35	Thusis	2306	28	46 41	−1·8	+0·5	−0·3	−0·5	7·2	12·4	14·1

TABLE (*continued*).

Reference No.	Station.	Altitude, H.	Longitude, L.	Latitude, φ.	Differences between the observed and calculated Temperatures.				Diurnal range of Temperature.		
					December 1863.	January 1864.	February 1864.	Winter 1863–64.	December 1863.	January 1864.	February 1864.
		feet.	h m	° ′	°	°	°	°	°	°	°
36	Ilanz	2310	0 28	46 47	−3·1	−6·2	−2·7	−4·0	6·7	13·9	13·9
37	Auen	2694	27	46 54	+1·3	+4·6	+1·3	+2·4	4·9	6·2	8·4
38	Vuadens.........	2707	19	46 37	−0·9	−3·0	−2·2	−2·0	7·2	9·3	9·7
39	St. Imier	2733	19	47 9	−0·1	−0·9	+0·6	−0·1	6·0	8·4	9·8
40	Uetliberg	2868	25	47 21	+0·5	+2·4	+1·2	+1·4	4·4	6·1	8·4
41	Einsiedeln	2986	26	47 8	0·2	−3·0	−2·9	−1·9	6·0	11·2	11·3
42	Trogen	3038	29	47 25	+3·0	+5·1	+2·5	+3·5	4·6	7·2	7·8
43	Chaux-de-fonds	3215	18	47 6	−0·9	−4·6	−1·3	−2·3	8·1	14·9	12·0
44	Engelberg	3360	24	46 49	+0·3	+0·3	1·7	0·4	5·1	7·0	9·3
45	Le Sentier	3360	16	46 36	−1·3	−7·8	−4·1	−4·4	8·1	10·4	10·4
46	Ste. Croix	3583	17	46 49	+1·1	+1·1	+0·6	+0·9	3·3	5·6	6·4
47	Beatenberg......	3773	22	46 41	3·6	5·1	2·4	3·7	5·5	7·9	8·5
48	Chaumont	3780	18	47 1	1·0	2·2	1·0	1·4	3·1	6·2	6·9
49	Closters	3921	30	46 52	1·1	3·2	1·3	1·9	6·4	10·9	9·9
50	Churwalden ...	3980	29	46 47	3·4	8·1	+3·8	5·1	4·8	7·0	7·0
51	Remiis	4088	32	46 50	+1·0	1·1	−0·3	0·6	7·5	11·1	13·2
52	Weissenstein ...	4213	21	47 15	−1·0	+0·9	+0·5	+0·1	4·3	4·8	3·9
53	Reckingen	4393	24	46 28	−3·2	−2·7	−1·9	−2·6	9·1	13·9	14·1
54	Platta............	4524	26	46 39	+2·2	+4·6	+2·8	+3·2	8·1	11·5	9·7
55	Andermatt......	4751	25	46 38	−2·1	−6·3	−1·5	−3·3	6·0	8·0	7·3
56	Splügen	4826	28	46 33	1·9	4·2	0·7	2·3	8·7	13·4	11·9
57	Zernetz	4843	31	46 42	0·9	−3·1	2·3	−2·1	10·9	17·5	15·6
58	Zermatt	5292	22	46 8	−0·1	+0·5	−0·1	+0·1	10·8	15·9	16·1
59	Grächen	5354	22	46 12	+2·2	+4·1	+1·6	+2·6	6·0	8·6	10·4
60	Bevers	5627	30	46 33	−3·5	−7·9	−4·2	−5·2	12·1	17·3	17·4
61	Stalla	5840	30	46 28	+1·0	+2·6	+1·8	+1·8	5·9	8·0	7·2
62	Righi	5853	25	47 3	1·9	+4·8	+2·3	+3·0	1·8	2·3	3·7
63	Sils...............	5912	30	46 26	+1·2	−2·9	−1·9	−1·2	9·2	13·9	14·7
64	Grimsel	6148	24	46 34	−0·2	−0·3	+0·2	−0·1	2·9	4·3	6·5
65	Simplon	6588	23	46 15	+1·5	+0·8	0·3	+0·9	3·8	5·5	7·0
66	Bernardin	6791	27	46 30	+1·6	2·1	0·8	1·5	4·0	5·0	5·8
67	St. Gothard ...	6867	25	46 33	0·0	+1·1	1·0	+0·7	4·3	8·2	6·9
68	Julier............	7362	30	46 28	−1·2	−0·1	+0·3	−0·3	5·0	6·4	10·1
69	St. Bernard ...	8130	19	45 52	+0·4	−0·2	−0·4	−0·1	3·2	4·5	6·3

The examination of the differences contained in this Table shows that they ought certainly to be attributed to local circumstances, which have modified the temperature observed in each station, and not to an error of the formulæ by means of which the temperature has been calculated; in fact this Table, in which the stations are arranged in order of height, does not enable us to recognize any law or regular progression in these differences and it would be the same were they arranged either according to longitude or according to latitude. It can also be seen that the difference shown by one station usually presents a great analogy for the three months, whether for the sign, or for the figure which is highest in January, particularly when the anomaly is a little marked; and as the formulæ differ very much from one month to another for the decrease with height, as well as for the variation according to longitude and latitude, we cannot fail to recognize a local cause, which has acted in the same sense in the three winter months.

The local causes which have been able to modify the temperature observed in any station whatever, and to assign to it a figure different to that resulting from the calculation of the whole of the sixty-eight others, can be classed under two different heads:—

1. Those which relate to the manner in which the mean temperature of a locality has been deduced from observations made in the station, or in other words, those the effect of which constitutes the error, or the uncertaintly that can be attributed to the determination of this mean temperature.

2. Those which relate to the influence of the configuration and the relief of the country in the neighbourhood of the station; these causes ought naturally to exercise a much greater influence in a country possessing so varying a surface as Switzerland, than in a level country.

The proof of this can be found in the fact that the amount of the anomaly is, with very few exceptions, very small in stations whose altitude is inconsiderable and which are situated in plains, or in the lower parts of valleys, where these valleys are wider and more open; in the same manner also only anomalies are found in the highest stations, situated on the summits of the Alps, and consequently less exposed to the influence of the chain. It is in the intermediate altitudes that the largest number of differences, showing a real anomaly in the temperature, are met with.

Were it possible to fix *à priori*, in each case, the amount at which we can value the uncertainty of the mean temperature which is assigned to a station according to published observations, we could, by comparison with the anomaly marked in the preceding Table, value the part which proceeds from the influences mentioned under the second head; but it is easy to show, in indicating the causes which may produce an error upon the figure of the temperature observed, that the results upon which a valuation of the uncertainty can be established will be defective. These causes are, first, those which take place in every observation, namely, errors of reading and errors of the instrument. We must then admit the possibility of an error of reading, in spite of all the care and all the exactitude that can be expected from the observer; such an error might more easily be overlooked in the bad season, when twice in the day the observation must be made with a light, and particularly in the higher stations, during very severe cold, or in a violent wind; besides, these accidental errors, which tend to counterbalance one another, can only alter the mean of the month by a very small fraction of a degree. As to the error of the instrument, although it would certainly be limited to a very small number of tenths, it is more serious, because it would alter all the observations made with the same instrument in an equal degree. The thermometers have been, it is true, constructed with the greatest care by the same artist, and according to the same model; they have been compared and verified at the period of their reception, but it is impossible to imagine that they would still be all exactly alike one year later, and that the habitual elevation of zero would not have altered their reading one-, two-, or three-tenths of a degree. A frequent verification of thermometers, which would enable the observer to determine the correction to be applied to each observation, cannot of course take place except in very few of our stations; as for the others, we are obliged to take the figures as they are observed, until a verification should take place by the members of the commission in the tour of inspection that they are required to make.

The particular position of the thermometer in each station is often a cause of error or anomaly; to render the observations as comparable as possible, the precaution has been taken of employing the same system in every place to shelter the instruments from the rays of the sun, or from the radiation of neighbouring objects. Nevertheless we must not despise the influence that the situation of a thermometer exercises on the temperatures that it indicates; besides, the choice of the situation was dictated in each case by special observations which vary between one station and another, to so great an extent that it was impossible to attain in this respect a complete uniformity. Thus we are obliged to admit, this having taken place in all countries, that the temperature observed in each locality is influenced by the particular character of the situation, and of the position of the thermometer, to an extent which varies in different stations; to this cause ought doubtless to be attributed, in a great number of cases, most of the uncertainty with which observations of temperature are attended. This uncertainty could not be estimated, or the correction which depends upon the situation of the thermometer determined, except by a very long series of comparisons between the readings of thermometers fixed in different situations on several points of the same locality.

Although it is impossible, according to the preceding considerations, to fix beforehand, and *à priori* for each station, the amount of the uncertainty of the mean temperature furnished by observation, we can at least calculate, according to the mean of all the stations, to how much the amount of the probable uncertainty rises; this is deduced from the sum of the squares of all the errors and constitutes the probable error, whether it be the limit of exactitude with which the formula represents the temperature of the whole of the system, or of the whole of Switzerland. In thus making, in each month, the sum of the squares of the errors, we find that the probable error or the probable uncertainty is—

In December 1863	±1°·0 Fahr.
In January 1864	±2·1
In February 1864	±1·1
For the winter	±1·3

These figures making us acquainted with the degree of exactitude to which we can lay claim in the comparison of the temperatures observed and the temperatures calculated, every anomaly which is comprised in these limits may be attributed to the uncertainty of the temperature observed; this cause being, in this case, quite as probable *à priori* as any other cause whatever. On the contrary, we have reason for admitting that in all cases where the deviation exceeds this limit, the climate of the adjacent country is modified by the influence of local circumstances, attributable to the configuration and relief of the country. Instead of repeating these cases separately for each month, I confine myself, for brevity, to indicating in the following Table the stations in which, according to the mean of the three months, the error of the winter temperature has exceeded ±1°·3 Fahr., an amount showing the probable uncertainty for the whole season; it is, in fact, most necessary to know the anomaly of the whole of the three months, and not that of such or such a part of winter. I indicate, besides, by initials each of the months in which the error has exceeded the probable error of this month; the stations are arranged according to the greatness of the anomaly, or the error, beginning with the most considerable, whether for positive or negative errors.

Errors exceeding the probable deviation.

Positive.			
Churwalden ...	Dec.	Jan.	Feb.
Beatenberg	"	"	"
Trogen	"	"	"
Montreux	"	"	"
Coire	"	"	"
Platta	"	"	"
Righi	"	"	"
Grächen	"	"	"
Auen	"	"	"
Altdorf...........	"	"	"
Closters	"	"	"
Stalla	"	"	"
Bernardin	"	"	
St. Gall	"		
Schwytz	"	Jan.	
Reichenau	......	"	Feb.
Chaumont	......	"	
Uetliberg.........	......	"	Feb.
Sargans	Dec.	......	"

Negative.			
Bevers............	Dec.	Jan.	Feb.
Sentier............	"	"	"
Ilanz	"	"	"
Andermatt	"	"	"
Reckingen	"	"	"
Splügen	"	"	
Zernetz	......	"	Feb.
Chaux-de-Fonds	......	"	"
Vuadens	......	"	"
Einsiedeln	......	"	"
Berne	Dec.	"	
Soleure	"	"	
Fribourg	......	"	

To complete this Table, I indicate again the cases (very few in number) in which the error of the temperature of a month has exceeded the probable error of this month, without the anomaly being extended to so considerable a degree as in other months, and consequently in the winter.

In December ...	Positive errors:	Zug, Sils, Simplon.
	Negative "	Martigny, Gliss, Thusis, Julier.
In January......	Positive "	——
	Negative "	Porrentruy, Bötzberg, Sils.
In February ...	Positive "	Bâle.
	Negative "	Kreutzlingen, Lucerne, Stanz, Altstätten, Engelberg, Sils.

It must first be remarked that of the sixty-nine stations, there are found thirty-four cases half below 700 metres, whilst of the thirty-two cases of a marked anomaly of the temperature, only ten are found to relate to stations in which the altitude is lower than this amount, and these ten cases, with the exception of Montreux and Coire, are placed at the foot of each of the series. Of the twenty-two other cases of a marked anomaly of the temperature, twenty-one are met with among the twenty-eight stations, whose altitude is included between 700 and 1800 metres, and only one (St. Bernardin) among the seven stations whose altitude exceeds 1800 metres. It is then between the limits of height of 700 and 1800 metres that the climate is most affected by local circumstances, judging by the comparison of the temperature of winter that we have made.

It would require a very extensive knowledge of topography, and of the surface of the country, even including some details that are not found in the excellent Map of Switzerland, such as the kind of cultivation or of vegetation of the soil, to indicate in each particular case the cause or causes, when the anomaly is due to the conjunction of several, to which an increase or decrease of temperature may be attributed. If we limit ourselves to enumerating the most general features which the topographic character of a locality can fix, we find that a station can be placed in the following positions:—

1. On an isolated peak, on the top or summit of a mountain.
2. On the side or slope of a mountain.
3. On a plain, meaning by that a region of a certain elevation, in which the surface of the ground might be very irregular, but not under the influence of any mountain in the immediate neighbourhood.
4. At the bottom of a valley; and in this case, which is the most frequent among our stations, there are several circumstances to which attention must be given, such as the width of the valley; the height and declivity of the chains which enclose it on each side; the relative position of these chains; the presence or not of forests on the sides of the mountain, or on the declivities which surround the station; the gradual narrowing of the valley, in consequence of which, whether eastwards or westwards of the station, it would be closed and reduced to a defile or a deep and narrow gorge, as frequently happens in the higher part, then the mouth of one or several lateral valleys in the neighbourhood of the station.

In most cases these general features of the topographical configuration of a place are sufficient to explain the anomaly which is produced in the temperature of winter; in fact, in this season, when the sun only remains a few hours above the horizon, and attains only a feeble height, the coldness of the soil by radiation is not counterbalanced by the heat due to the influence of the sun; the soil is consequently habitually colder than the superficial beds of air; these latter are colder than those which are placed above them, and thus in succession to a certain height. During the greatest part of the duration of winter, a confusion in the neighbourhood of the soil is thus produced in the decrease of the temperature with height; the soil is the coldest, then the layers in contact with it, and the temperature rises rapidly first, then more slowly to a certain height, starting from which it decreases in proportion as the height augments*. If the station is in a level country, where the surface is perpendicular to the vertical, the coldness of the soil and the layers of air which are in contact with it gives place to no local atmospheric current, the coldest and densest molecules of air everywhere occupying a lower plain, and forming a layer parallel to the soil and perpendicular to the vertical; and even a gentle wind, which would cause a constant renewal of the molecules of air situated above a given place, would not produce a change in the temperature, since the conditions are the same throughout the whole of the neighbouring region. It is not the same in a mountainous country, where the coldness of the layers in contact with the soil produces necessarily, by reason of the declivity of the soil, a local atmospherical current, and where the molecules of air, which are successively brought to a given place, can proceed from warmer regions, and consequently raise the temperature of the station, or from colder regions, and in this case lower it.

Whenever the soil is colder than the air placed above, the molecules of air of the superficial layers will become cold by contact, and thus becoming denser, they will tend to descend if the ground is inclined; this movement being constantly repeated, it will produce along the slope a descending current, a phenomenon well known to all those who inhabit mountains or who have studied them. The direction and intensity of these descending currents are modified by folds or irregularities of the ground, and in the same manner as currents of water, they tend to converge and to become united in depressions, such as gorges, passages, or ravines, which serve them, so to speak, as beds.

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* I shall quote in support of this, the interesting researches recently made on this subject at Montpellier by Professor Martins, the experiments made previously by Mr. Marcet, &c.

Every atmospheric current is necessarily accompanied by a counter current; it must consequently be admitted that the molecules of air attracted by the descending current are replaced by a counter current placed above this latter. If the station is situated on an isolated peak, as the Righi, or on the top of a mountain-chain, as on Chaumont or Uetliberg, the counter current incessantly brings air, arising from layers placed at a greater distance from the ground, and consequently warmer, therefore the temperature of these localities becomes relatively higher. The Weissenstein alone, among the stations placed in an analogous situation, does not present a marked anomaly under the relation of the elevation of the temperature; it is nevertheless remarkable that the temperature there has been relatively milder than at Soleure, which is situated at the foot of the Jura. In stations in the defiles of the Alps, as Simplon, Bernardin, St. Gothard, Julier, and St. Bernard, the increase of temperature produced by the counter current can, according to the configuration of the locality, be neutralized and counterbalanced by the current descending from the summits which surround the defile; therefore we only find in these five stations very small anomalies, excepting Bernardin, where the positive error is very marked.

In localities situated on the side of mountains, the influence of the counter current will tend again to raise the temperature, although in a less evident manner in general, than on the summits in similar situations; the details of the topographical configuration of the soil in the neighbourhood of the station can produce very considerable differences. Thus the depressions on the side of the mountain, the gorges, and ravines which serve as beds for the descending current, can give place to a local and very considerable decrease of temperature, whilst the most striking parts, the eminences (the general situation chosen for the sites of villages), will be, on the contrary, favoured, the counter current incessantly bringing air which has not become cold by contact with the soil. Two stations of our system which are found in such a position, Beatenberg above the Lake of Thoune, and Grächen on the side of the chain which bounds the valley of St. Nicolas on the east, both present a very marked anomaly in elevation of the temperature; the error is not so large for Grächen, which is exposed to the winds of the north, whilst Beatenberg, placed on the south side, is sheltered from them. A circumstance that ought to be noticed as tending to exercise a rather considerable influence in all places situated on a mountain-slope, whether at the foot or halfway down, is the existence or absence of forests on the declivities which surround this place. In the same manner as the soil becomes less warm under the action of the rays of the sun in a region covered with forests, so it becomes much less cold by radiation; besides in this case the descending current meets obstacles which diminish its intensity. This influence, which can be attributed *à priori* to forests, is confirmed in a great number of cases; and there might be some interest in noticing the painful effects arising from the want of vegetation on the declivities of mountains, the deterioration which results from it in the climate of the localities which are situated below these declivities, in rendering the colds of winter more severe.

After what has been previously said of the currents of cold air which descend along the sides of the mountains, we ought to expect to find at the bottom of the valley, in its deepest part, le Thalweg, a temperature considerably lower than anywhere else, the coldest molecules, and consequently the thickest, occupying the lower plain; le Thalweg thus serves as a bed for a current of cold air, just like a torrent or a river. Although the space occupied by the current of cold air is more considerable than the bed of a torrent, it is nevertheless limited, and particularly if the valley is of rather a considerable width; or if the Thalweg is very confined between high precipices, the decrease of temperature could be limited to a narrow zone*, so that the parts of the valley placed beyond these limits would be in a situation analogous to those which are found on the side of mountains. Thus could be found in places which, thanks to their position and the topography of the earth, are beyond the current of cold air, and can even owe a temperature relatively high to certain particular circumstances, such as the shelter offered by the mountains against the winds from the north, particularly if the declivities are wooded, the neighbourhood of a lake, &c. Coire, Platta, Auen, Altdorf, Closters, Stalla, Schwytz, Sargans are thus circumstanced; and Montreux could be also placed in the same category, with this difference, that the lake which occupies the bottom of the valley, or the Thalweg, is in winter a source of heat and not of cold.

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* In support of this, it is sufficient to call to mind the very abrupt changes of temperature, rising often several degrees in a very short space of time, that are constantly met with in valleys, if in crossing them either perpendicularly or diagonally we pass through one of the affluents of cold air which come down the sides of the mountain and follow the ravines or depressions caused by lateral valleys.

The zone near to the deepest part of the valley of Thalweg, and which is consequently on the passage of the current of cold air descended from the heights, is certainly considerably colder than all the others which are similarly situated; there is only one exception, it is Reichenau, and this exception is the more curious, as this place is situated at the meeting of two branches of the Rhine, a circumstance which would tend still more to lower the temperature. I have not a sufficient knowledge of the locality, through which I have only hurriedly twice passed, to be able to point out the cause of this anomaly; perhaps it is caused only by the position of the thermometer, and by the manner in which the instrument is exposed. The most striking example of the extraordinary decrease of temperature met with in certain parts of the valleys is Bevers, a village which enjoys the reputation of being the coldest part of la haute Engadine, whose climate is nevertheless very severe; the observations of last winter have confirmed this reputation, in fact Bevers has been not only relatively the coldest place of all our stations, since it presents the greatest anomaly (26°·8 Fahr.), but it has been actually so. The mean temperature of Bevers has been 7°·7 Fahr. in January, and for the winter 15°·1 Fahr., whilst the mean temperature of Julier has been 13°·0 for the month of January, and 16°·5 for the winter, and that of St. Bernard 16°·4 in January, and 17°·6 for the winter; and yet le Julier is more than 500 metres, or 1640 feet higher, at a distance of only some leagues; St. Bernard is nearly 800 metres higher, or 2625 feet, but the geographical position is very different. The exceptionally severe cold of this locality might perhaps be attributed to the circumstance of its being placed at the mouth of the vale Bevers, in the valley of Inn, consequently at the meeting of two currents of cold air.

A feature in the topographical configuration of a valley whose influence is very appreciable, is that of a gradual narrowing or contraction, which, by opposing an obstacle to the current of cold air, transforms it into a basin almost closed, in which the temperature has a constant tendency to decline, since the densest molecules of air, and consequently the coldest, are precipitated into it from all sides, without finding any issue as in open valleys. This frequently takes place in the longitudinal valleys between the parallel chains of the Jura, of which the severe temperature in winter is a well-known fact; among our stations, le Sentier in the valley of Joux, and la Chaux-de-Fonds, are examples of it, and offer, the first particularly, a very marked negative anomaly. The contrast is striking, if we compare the temperature of St. Imier, which is also placed in a longitudinal valley of the Jura, with that of St. Croix, which is in a valley perpendicular to the chain. In the valleys of the Alps this accident presents itself frequently and under different circumstances; thus when a valley is parallel in its higher part to the direction of the principal chain, then changes its direction by making nearly a right angle, it is usually reduced at the place where the bend is to a very narrow defile of considerable length. This is found in a very striking manner at Andermatt, where the valley of Urseren is almost entirely obstructed by the northern chain, which leaves only a narrow cleft for the passage of the Reuss. The negative anomaly of Andermatt is very marked; and the fact that the sides of the mountains which bound the valley of Urseren are entirely without trees, contributes doubtless to augment the cold in this locality. In the valley of the Rheinwald is situated the village of Splügen, a little below which the Rhine changes its direction by crossing a succession of defiles. It is to be remarked that valleys parallel to the principal chain are generally colder than those whose direction is perpendicular to this chain.

The contraction of a valley can take place without a change of direction, in consequence of the approach of the mountains on each side; for instance, this takes place near Ilanz; a little below this town the valley is almost closed, and the Rhine flows at the bottom of a very narrow deep gorge confined between two almost vertical precipices; the negative anomaly in the temperature of this valley is also very strong, a result to which may be attributed the fact that the sides of the mountain on the left bank are bare and without trees. The valley of Conches in the Haut-Valais is equally confined below Reckingen, either by a projection from the northern chain advancing into the valley, or by the approach of the mountains on each side; in this station as well is found a very marked negative anomaly in the temperature of winter.

The anomalies of temperature met with in stations situated on plains are more difficult to be explained by general rules; in fact, in regions in Switzerland that may be called plains, the ground is anything but flat; it is very irregular, and the rise or fall of the temperature depends upon the topographical configuration peculiar to each locality. Thus the elevated region in which the village of Churwalden, above Coire, is situated cannot be otherwise designated than by the term of plain; in this station the greatest positive anomaly is found. Trogen, in the Canton of Appenzell, and St. Gall also present positive anomalies, that is to say, a temperature relatively high; whilst Einsiedeln, the position of which is nearly analogous to that of Trogen, in general features at least, shows rather a large negative anomaly. A sufficiently marked anomaly is also found in the region of the plains of the south-west part of Switzerland, which includes the stations of Vuadens, Fribourg, and Berne. In each of these cases it would require a special study of the locality, the local winds, &c. to indicate the causes which produce in one place a positive, in another a negative anomaly.

To complete this work, I have now to compare the temperatures observed in the stations of the Swiss system south of the Alps; these stations are too small in number, and are too near each other, whether in a vertical or horizontal sense, to enable me to think of determining on these observations alone, the law according to which the temperature varies from one to another, in consequence of height, of longitude, and latitude. The extreme variations between one station and another which might be produced by the action of one or other of these causes, are in fact less than those that might be attributed to the influence of local circumstances, and as the observations are too few in number for the effect of these anomalies to be eliminated in the result obtained, this latter would merit no reliance. Neither can we compare the temperature observed in these southern stations with the temperature calculated by the formulæ found previously, having regard to the terms depending on the difference of longitude and latitude; in fact, as we have shown, the manner according to which the temperature varies with longitude and latitude, in stations situated north of the Alps, depends on the position and the direction of this chain, and on its influence upon the temperature of neighbouring countries, consequently these terms, and particularly that relative to latitude, are not applicable to the south of the Alps. If we put these terms aside, having regard only to terms relative to the decrease of temperature with height, we find in the following Table for each month, how much the temperature observed in each station is above that which, according to the whole of the southern stations, we should find at the same altitude for the point whose coordinates are

$$I=0^h\ 24^m\ \phi=46^\circ\ 50'.$$

Station.	Alt. H.	Long. L.	Lat. φ.	Differences between the observed and calculated temperatures.				Diurnal range of temperature.		
				Dec.	Jan.	Feb.	Winter.	Dec.	Jan.	Feb.
	feet	h m	° ′	°	°	°	°	°	°	°
Locarno	715	0 26	46 10	+4·7	+7·6	......	......	10·7	12·4	...
Bellinzona......	751	27	46 12	6·1	6·5	+3·2	+5·3	10·0	11·1	8·8
Lugano	902	27	46 0	4·8	6·9	3·1	4·9	12·1	14·1	12·0
Mendrisio	1165	27	45 52	5·5	6·4	3·2	5·0	8·2	8·5	7·2
Castesegna......	2287	29	46 20	7·9	5·5	3·0	5·5	3·1	5·0	7·3
Faido............	2369	26	46 29	7·6	5·1	2·5	5·1	4·3	5·7	7·2
Brusio	2585	31	46 15	+9·6	+8·7	+3·6	+7·3	5·6	6·5	5·9
Means	......	0 27·6	46 11	+6·6	+6·7	+3·1	+5·5	...	...	...

Thus we see, according to the mean of the errors for the seven stations (six only in February), how much at an equal height the temperature is above for a point situated south of the Alps at $0^h\ 27^m{\cdot}6$ longitude and 46° 11′ latitude—that according to 69 stations, north of the Alps, for a point whose longitude is $0^h\ 24^m$ and latitude 46° 50′, the difference is in the month of

December 1863, of +6°·7 with a probable uncertainty
of ±0°·4 Fahr.
January 1864, of +6°·7 with a probable uncertainty
of ±0°·4 Fahr.
February 1864, of +3°·1 with a probable uncertainty
of ±0°·1 Fahr.
For the Winter, of +5°·5 with a probable uncertainty
of ±0°·3 Fahr.

These figures cannot, it is true, be taken as strictly expressing the influence of the mass of the Alps upon the temperature of the two opposite sides, since the geographical coordinates are not quite the same for the two points compared. In each instance the distance is not very considerable, since one is found only 100 kilometres south-west of the other in a direct line, the difference of longitude being 54′, and that of latitude 39′. If, moreover, we take into consideration the circumstance that in winter the isothermal lines usually follow in this part of Europe the direction from north-west to south-west, we shall be able to regard these figures as representing very approximately the influence of the large mass of the Alps on the temperature of the two opposite sides during last winter, how much, all else being equal, the temperature has been higher on the southern side. It is to be remarked that the month of February presents an increase of temperature considerably less than the two other months; and it would be interesting to discover if this difference is simply accidental and is due to a special anomaly of the year 1864, or if it will also take place in following years. We can then see that, with the exception of Brusio, we find in no other station marked anomalies which could be attributed to the influence of local circumstances; at Brusio we notice a similar anomaly, rising to one degree nearly, whose temperature is higher.

It will not be perhaps out of place to call to mind, in ending this work, that the observations upon which it is based have relation only to the winter of 1863–64, and indicate to what point results might differ for another year. The only comparison of the variation of temperature according to height, of longitude or latitude, of one month with another of last winter, consequently the same meteorological season, shows that the variation might also differ very much from one year to another for the same month. The recent researches of Prof. Dove on the isothermals corresponding to such or such a period, during which the temperature wandered considerably from its normal value, prove the fact that we can trace on the surface of Europe the region where the relative pole of cold or of heat is found at this time*. It is in this region that the greatest amount is met with, whether of increase or decrease, for the anomaly with the normal temperature of the locality, and it is round this pole that we can trace the lines uniting all the points for which the figure of the anomaly is the same; these lines, called isothermals by M. Dove, are much more distant from the relative pole than the absolute figure of the diminished error; and starting from the line where the anomaly is nothing, we find those of which the figure of error increases, but with a contrary sign. M. Dove has not extended his researches, except to some very exceptional months; but analogous anomalies in the distribution of the temperature reproduce themselves, so to speak, every month, only in a less degree, in such a manner that the isothermals do not attain so high a figure. As the relative pole of heat or of cold may be found sometimes in one part of Europe, sometimes in another, it is evident that, according to its position, the variation of the temperature according to longitude and latitude will be likely to be very different.

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* In some cases, as in February 1845 and December 1846, there are found, even in the limits of Europe, two regions of relative maximum cold, or two poles of relative cold.

As to the decrease of temperature with height, results so dissimilar found in the three winter months lead us to suppose that we should obtain a very different law for the decrease, for the same months in another year. This supposition is besides fully confirmed by the comparison of the difference of temperature between Geneva and St. Bernard during a series of years. These two stations are near enough in a horizontal sense; the distance measured in a direct line is only 85 kilometres, so that the anomalies in the distribution of the temperature, according to longitude and latitude, of which we have just been speaking produce only a very inconsiderable influence on these differences, and in every case much too small an influence for the errors observed to be attributed to it. This is easily shown by quoting some figures in support of it. According to the value of the mean temperature of each month, deduced for Geneva from a series of thirty-five years, and for St. Bernard of twenty years, the difference of temperature between these two stations is, in mean, in the month of December 47°·8, in the month of January 48°·6, and in the month of February 50°·5; here is now the figure of the differences observed in each of these months during the last fourteen years. Following the custom adopted by meteorologists of uniting the three months of winter which follow each other in the same season, and consequently commencing the meteorological year with the month of December, each month of December written in this Table corresponds to the preceding civil year. After the difference observed in each month, I have added the positive or negative anomaly for Geneva and St. Bernard, that is to say, the amount by which the temperature has been higher or lower than usual in each station.

This series of fourteen years is consequently sufficient to show the enormous variations that may be found from one year to another in the decrease of temperature corresponding to 2070 metres or 6791 feet in height; in 1852, in the month of December (1851, civil year), the temperature of the lower station was only 38°·3 higher than that of the higher station, whilst in 1861 (1860, civil year) the difference rose to 54°·2. In the month of January, the extreme values of the difference are 39°·3 in 1861 (a figure again considerably lower than that of 1864), and 52°·9 in 1857; in the month of February we find 46°·6 in 1856, and 56°·9 in 1853, and in all probability, in taking a longer series of years, we should find still wider extremes.

Year.	Differences between the Temperatures of Geneva and St. Bernard, and Anomalies at each Station.								
	December.			January.			February.		
	Geneva, St. Bernard.	Anomaly.		Geneva, St. Bernard.	Anomaly.		Geneva, St. Bernard.	Anomaly.	
		Geneva.	St. Bernard.		Geneva.	St. Bernard.		Geneva.	St. Bernard.
	°	°	°	°	°	°	°	°	°
1851.	+12·9	+0·9	+3·8	+15·2	+1·9	+3·3	+17·9	−0·1	+0·6
1852.	6·3	−7·7	+1·8	16·7	+4·7	+4·6	21·5	+1·9	−1·0
1853.	12·6	+4·4	+7·6	19·9	+6·3	+2·9	24·9	−2·8	−9·2
1854.	16·4	−4·9	−5·4	13·8	+0·4	+3·2	19·4	−4·3	−5·2
1855.	21·5	+3·0	−2·6	16·1	−2·2	−1·7	17·4	+0·9	+2·0
1856.	15·3	−6·6	−6·1	18·1	+5·0	+3·4	14·7	+3·4	+7·3
1857.	16·5	+0·2	−0·4	20·9	+0·2	−4·1	15·1	−2·7	+0·7
1858.	9·2	−0·6	+6·0	15·4	−3·9	−2·8	19·1	−1·4	−1·9
1859.	18·7	+2·1	−0·7	16·0	+0·4	+1·0	19·0	+1·3	+0·8
1860.	18·7	−3·1	−6·0	19·6	+6·3	+3·2	20·9	−4·8	−7·1
1861.	22·2	+1·2	−5·2	7·3	−4·0	+5·2	17·6	+3·1	+4·0
1862.	11·5	−0·7	+3·6	17·6	+2·2	+1·1	15·6	+0·2	+3·1
1863.	16·8	+2·2	+1·2	17·2	+5·0	+4·4	14·7	+0·7	+4·5
1864.	+13·6	+1·5	+3·7	+10·2	−5·3	+1·1	+18·4	−1·7	−1·6

If we compare the difference of temperature between two stations with the anomalies observed in each of them, we can make the following deductions:—(1) When the difference varies little from its real value, this result can proceed from three different alternatives, either from smallness of the anomaly in the two stations, as in December 1857, January 1859, February 1851, or because the month has been nearly equally cold in both, as in December 1854 and 1856, January 1855, February 1854, or else in fact because the month has been nearly equally warm, as in December 1863, January 1852, February 1861. (2) When the difference is considerably less than usual, this result may be due, either to a very great decrease of the temperature in the lower station, as in December 1852, January 1864, or a very considerable elevation in the higher station, as in December 1858, January 1854, February 1863, or else in fact to the united action of these two causes, as in January 1863. (3) When the difference is more remarkable than usual, the result may be due, either to the elevation of the temperature in the lower station, as in December 1859, January 1853, or the decrease of temperature in the higher station, as in December 1861, January 1857, February 1853, or else to the conjunction of these two causes, as in December 1855, February 1852.

Up to the present time we have been able to prove only the variations in the difference between the temperatures of two points placed at 2070 metres one above the other, without having observations necessary for finding the decrease for the intermediate points; the establishment of the Swiss meteorological stations supplies this want, and will place at our disposal all the elements necessary for determining for any month whatever, with great exactitude, the law of the decrease of temperature with height, up to 2500 metres.

We have still to examine how far the anomalies which presented themselves last winter in such or such a station, and those we have attributed to the influence of local circumstances, are susceptible of variation from one year to another. That the amount of the anomaly might vary from one year to another in the same month is beyond doubt, and the proof of it is that this amount has been much greater in the month of January than in the two other months, whether in the stations where it was positive, or in those in which it was negative; but it is to be presumed that the sign and size relative to the errors will reproduce themselves nearly the same from year to year for the same stations, in such a manner that we might always arrange those in which the temperature is exceptionally severe to the size of the errors. These anomalies have been, in fact, attributed to local winds, to atmospheric currents produced by the topographical configuration, and the relief of the country in the neighbourhood of the station; besides, it is easy to understand that it is only in the absence of a general wind that these local atmospheric currents are produced, and that they ought, on the contrary, to tend to disappear every time that the atmosphere is violently agitated by a general wind, extending over rather a considerable surface. Anomalies due to local circumstances will be consequently more marked during a month in which the equilibrium of the atmosphere has been less frequently troubled by a general agitation, by violent winds, extending over a vast surface of country, than in another in which these last, on the contrary, have been frequent. It is the first of these alternatives which presents itself in the month of January 1864; to the agitation of the atmosphere caused by the violent wind from the north, which blew during the three or four first days, succeeded a period of calm, which lasted almost without interruption up to the end of the month, and starting from the three or the four, the barometric pressure is maintained at a high plane with very small variations only. The general circumstances have been also, during this month, as favourable as possible to the production of local atmospheric currents, which accounts for the high figure that we find for local anomalies of temperature.

In accordance with the plan that I proposed to myself, I have studied the distribution of the temperature during a period embracing a whole month; this study could be extended to shorter periods of some days only, or day by day. We could in particular arrive at some very curious results by comparing the temperature of each of the days of the month with that of the mean of the month. This Table would show that during the invasion of the great colds in the commencement of January, as well as the decreases which have taken place at different times, at the end of this month and in February, it is in the high stations that the decrease of the temperature is first manifested one, two, or three days sooner than in the plain; and in the valleys the relative decrease of the temperature has been prolonged during a much greater number of days without attaining so great a value. I must confine myself to these indications, without entering into a detailed account, which would take me too long, because it would at the same time require the examination and consideration of several other circumstances, such as the state of the sky, the wind, the atmospheric pressure, &c. The necessary materials for this study are found, great part of them at least, in the pamphlets of meteorological observations already published.

BOOKS AND NOTICES.

XXVIII. *On the Fall of Rain during the different Hours of the Day, as deduced from a Series of Observations made by the Rev. J. C. Bates, M.A., F.R.A.S., at St. Martin's Parsonage, Castleton Moor.* By JOSEPH BAXENDELL, Esq., F.R.A.S.

[From the 'Proceedings of the Manchester Literary and Philosophical Society,' vol. v. No. 12, Session 1865–66.]

IN the spring of last year, the Rev. J. C. Bates, M.A., F.R.A.S., of Castleton Moor, contrived a rain-gauge by which he is enabled to determine the amount of rain which falls during every quarter of an hour of the entire day. Observations with this instrument were commenced on the 24th of May last, but were interrupted for two days in October, owing to damage done by the violent gale of the 25th of that month, and again in December, while the driving clock was under repair. All the observations made up to the end of January have been kindly forwarded to me by Mr. Bates for examination and discussion, and although the series extends over a period of only a little more than eight months, and caution is, therefore, required in basing general conclusions upon it, yet the results I have obtained appear to me to be sufficiently remarkable and interesting to be worthy of being brought at once under the notice of meteorologists, in order that the law of daily variation of rainfall which they indicate may be tested by the results of similar series of observations made in other localities.

The number of days in each month on which the rainfall was registered by the new instrument was—May 5, June 4, July 19, August 20, September 3, October 14, November 9, December 5, January 21: total 100 days. The total amount of rain registered during the 100 days was 21·854 inches.

Arranging the amounts of rainfall in twenty-four groups corresponding to the twenty-four hours of the day, and taking the sums of the amounts in each group, we have the following results:—

Hour.	Number of times Rain fell during the hour.	Total amount of Rain. inches.
1	21	0·536
2	27	0·619
3	28	0·774
4	29	1·124
5	26	1·042
6	33	0·650
7	35	0·728
8	33	1·263
9	32	1·132
10	34	0·909
11	38	0·854
12	41	0·879
13	34	0·734
14	37	0·921
15	35	0·907
16	35	1·068
17	30	0·884
18	34	0·964
19	32	1·162
20	36	1·083
21	32	1·350
22	23	0·658
23	25	0·828
24	24	0·835
		21·854

Dividing the twenty-four hours into day and night periods of twelve hours each, we have:—

	inches.	Frequency.
Total rainfall from 6^h A.M. to 6^h P.M.=	10·925	337
" " 6^h P.M. to 6^h A.M.=	10·929	417

It appears, therefore, that the average fall of rain during the night was sensibly the same as that during the day; but the frequency of rain was much greater during the night than the day.

Dividing the day into four periods of six hours each, we have—

	inches.		Frequency.
Noon to 6h P.M.	4·930	......	155
6h P.M. to midnight	5·536	......	205
Midnight to 6h A.M.	5·393	......	212
6h A.M. to noon	5·995	......	182

These results show that the greatest amount of rain fell in the fourth quarter of the day, reckoning from noon; and the least in the first quarter; and that the amount which fell in the second quarter was slightly in excess of that which fell in the third. The frequency of rain was least in the first quarter and greatest in the third.

The six consecutive hours in which the largest quantity of rain fell were from 4h A.M. to 10h A.M., the amount being 6·461 inches, and the amounts in the three following six-hourly periods were:—

10h A.M. to 4h P.M.	4·250 inches
4h P.M. to 10h P.M.	5·939 „
10h P.M. to 4h A.M.	5·204 „

If now, the numbers in the last column of the above Table are arranged in eight groups, and the sums of the numbers in each group taken, we have the following remarkable results:—

Hours.	Total amount of Rainfall.	Frequency.
1, 2, 3,	1·929	76
4, 5, 6,	2·816	88
7, 8, 9,	3·123	100
10, 11, 12,	2·642	113
13, 14, 15,	2·562	106
16, 17, 18,	2·916	99
19, 20, 21,	3·545	100
22, 23, 24,	2·321	72

Projecting these numbers on ruled paper, and drawing a curved line through the points thus laid down, we obtain a well-marked curve, having two maxima and two minima, which occur at the following hours:—

Principal maximum at	8½h A.M.
Secondary „	8h P.M.
Principal minimum at	2h P.M.
Secondary „	1½h A.M.

This curve has no similarity to that of daily temperature, but has a strong resemblance to the curve of diurnal variation of the barometer, with a difference of about two hours in the times of occurrence of the maxima and minima. The regular diurnal variations of the barometer in this latitude are, however, so small that it is hardly conceivable they can produce the great differences in the amounts of rain falling at different periods of the day as indicated by Mr. Bates's observations. The curve of daily variation of the intensity of atmospheric electricity has also strong points of resemblance to the rain-curve, but its night minimum is the principal one, and most meteorologists will probably regard variations of intensity of atmospheric electricity as consequences rather than causes of the changes in the amount of condensed vapour precipitated in the form of rain. No other meteorological phenomenon is at present known having diurnal variations similar to those of the rainfall; but if we turn to the phenomena of terrestrial magnetism, we shall find that the curve representing the daily variations of declination of the magnetic needle has well-marked points of similarity to that of the daily rainfall. Taking for data the mean results of ten years' observations of magnetic declination made at the Royal Observatory, Greenwich ('Greenwich Observations for 1859'), we have the following comparison of the times of maxima and minima of the two phenomena, the westerly deviations of the magnetic needle from the mean position being taken with a negative sign.

	Daily Rainfall.		Daily oscillations of Magnetic Needle.
Principal maximum at	8½$^{\mathrm{h}}$ A.M.	……	10$^{\mathrm{h}}$ A.M.
Secondary „	8$^{\mathrm{h}}$ P.M.	……	7½$^{\mathrm{h}}$ P.M.
Principal minimum at	2$^{\mathrm{h}}$ P.M.	……	1$^{\mathrm{h}}$ P.M.
Secondary „	1½$^{\mathrm{h}}$ A.M.	……	8$^{\mathrm{h}}$ A.M.

Owing to the shortness of the period over which Mr. Bates's observations extend, it is probable that the results derived from them may be open to considerable correction, when a more extended series becomes available. I find, however, that when this short series is divided into *two* or even *three* groups, the main features of the daily variation are still preserved in the results of each group, and I do not, therefore, anticipate that any corrections which may hereafter be found to be necessary, will be of such a character as to affect materially the probability of a close connexion between the daily variations of rainfall, and the diurnal oscillations of the magnetic needle, and I hope to be able in a future communication to bring forward other facts and results bearing upon this interesting and important question.

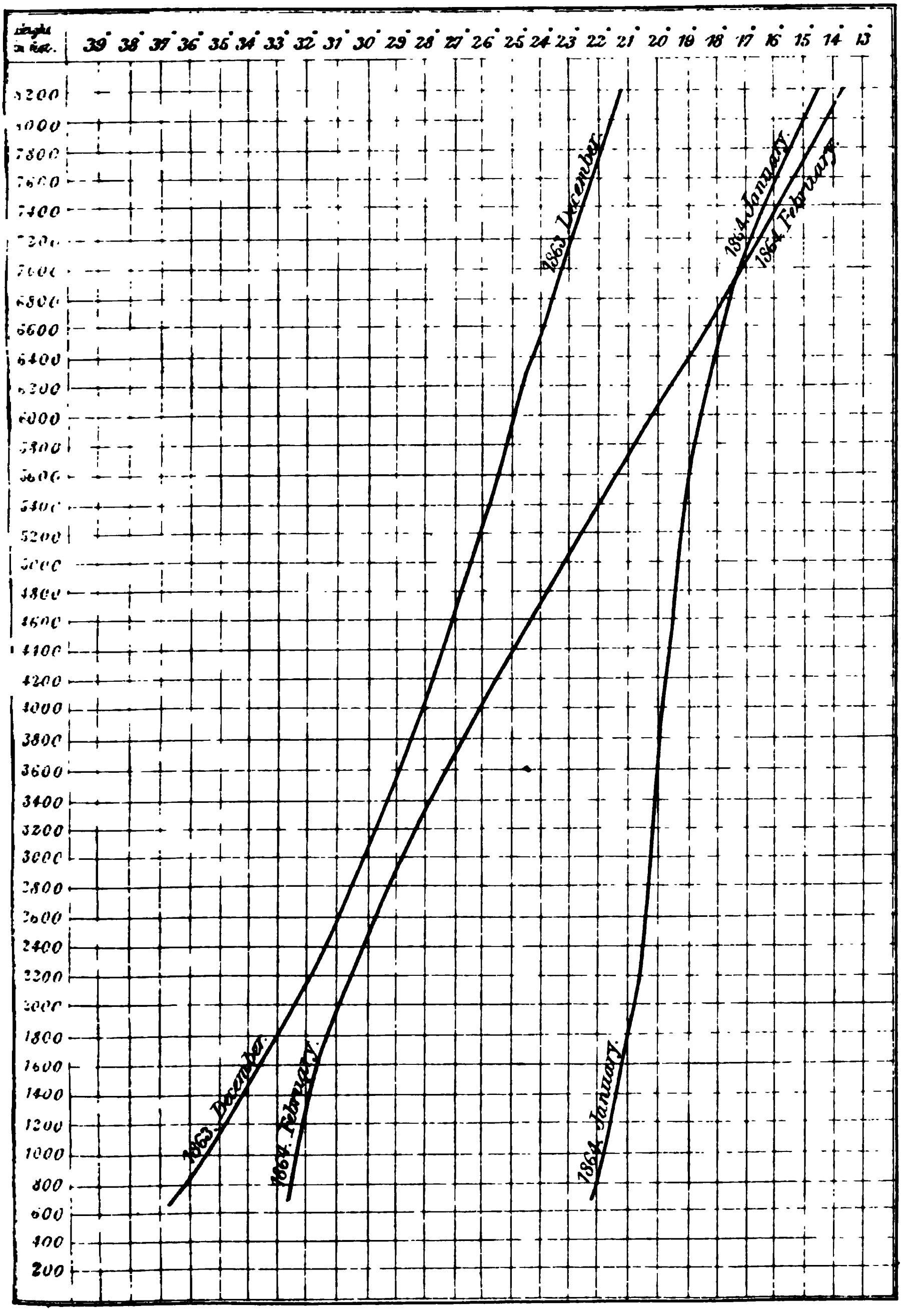
Whatever views may be taken as to the cause of the unequal distribution of the rainfall in the different hours of the day, it could, at all events, hardly have been expected that the greatest amount of rain would fall at that period of the day when the rate of increase of the difference between the temperature of the dew-point and that of the air, is greatest; and when, therefore, according to generally received meteorological principles, there would appear to be little probability of a condensation of vapour into the form of rain.

I cannot conclude this communication without gratefully acknowledging the kindness of Mr. Bates, in affording me an opportunity of examining his valuable observations, which form, I believe, the only series of the kind ever yet made.

Proc. Met. Soc. Plate II.

Switzerland.

Curves representing the decrease of Temperature with increased height during the Winter of 1863-64.



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OF

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SESSION 1865–66,

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„	February..................	21	„	June	20

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EDITED BY

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1866, APRIL 18.

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H. E. Westcar, Esq., Royal Horse Guards, Windsor;
W. Whitehead, Esq., L.F.P.G., L.M., L.S.A., Mansfield, Woodhouse, Notts;

were balloted for and duly elected Fellows of the Society.

The names of Four Candidates for admission into the Society were read.

CXVIII. *Analysis of the Winds.*

By John C. Bloxam, Esq., M.R.C.S.

The prospect of arriving at an understanding of the atmospheric currents, of tracing both their causes and their effects, would be improved if a better system of stating their directions were in use. The directions are commonly given under heads of too great a range in the first tabulation. The division and arrangement of materials is necessarily arbitrary, and ought to be uniform in the first instance, and if the arbitrary divisions are so comprehensive as to include at random both high and low values in the same category, this must create an obstacle to the work of deducing laws from observed facts, which might be avoided. The circle, moreover, is commonly divided at such points as seems most calculated for masking instead of elucidating the facts. The cardinal points of the compass are the limits to what are supposed to be natural groups; it therefore seems to be injudicious to make the cardinal points the centres, instead of the limits, of artificial divisions. A discussion, founded on a quadrantal division of the circle, with the cardinal points for limits to the quadrants, is more likely to lead to satisfactory results than the more usual octagonal division. If any such discussion should be considered of little worth, still tables giving values for each of the thirty-two points, constructed with rigorous attention to accuracy and founded on careful observation, may be deemed valuable. Such tables would be rendered far more useful by dividing the year into more than twelve parts, provided the record were sufficiently extensive; but they would be impaired in value if the time-categories were made too contracted for the extent of the facts collected. It will be right to preface the following statement with an explanation of the means employed for determining the direction of the wind, the method used for observing and recording, and the treatment the daily record was subsequently subjected to.

The direction the lowest range of clouds moved in was the indication generally used for the direction of the wind. The direction the clouds moved in was ascertained by observing their progress against a perpendicular pole, such as is commonly used for supporting wind-vanes, the observer standing at a distance from the pole and in the direction of the wind. The points of the compass were marked on the ground around the pole, and their position was determined accurately by that of the sun when at East, South, and West. The mark nearest the pole was 40 feet from it. A common wind-vane was placed on the summit of the pole, to assist when the clouds gave an insufficient indication. A careful observation was made habitually at noon each day; but the vane was, in a manner of speaking, constantly under observation; changes in the direction were thus detected, and the precise change was ascertained by looking to the pole. Very generally the direction could be determined readily to less than half a point (*i. e.* less than $\frac{1}{64}$ part of the circle). The site of observation was at Newport, in the Isle of Wight, lat. 50° 42′ N., long. $5^m 9^s$ W. The observations were made and recorded with a view to grouping the directions eventually under the heads of the four cardinal quadrants—that is to say, the arcs bounded by true North, South, East, and West. The direction was never registered under the head N., S., E., or W., unless it were so close to due N., S., E., or W. that it could not be pronounced to be on either side of such exact direction, and this did not often happen. Supposing the direction to be in the smallest degree east of north, it would then be registered as N. by E., although the direction were within the limits of the north point. There were consequently fewer days given to the four cardinal points than really belonged to them, and the eight points next to the cardinals had an excess given to them. Each of these groups, however, of three points was correct as a group. It was not always possible to pronounce any one point to be the prevailing one for the day, and then some modifying expression was inserted in the registry; if it was ascertained what individual point the wind was *near* to, the word "about" was added to the name of that point. If the direction varied during the day, but the cardinal quadrant could be specified that it adhered to, the entry for the day would then be in the form "between N. and E." If the prevailing semicircle only could be named, the form of the entry would be "Northerly." When the direction varied beyond these limits, it was entered as "Variable." It happened occasionally that the direction was not ascertained at all, and then a blank was left. All these imperfect notices have been set aside in the first tabular compilation. The number of days included in the sixteen years during which the observations were carried on (viz. 1841–56) being 5844, this number was reduced by these omissions to 4809; so that the sixteen years were reduced nearly to thirteen as regards the sum of the recorded directions, though not as regards the period of time they extended over. The omissions made in each of the twelve months were as follows:—

	Days.
January	84
February	68
March	81
April	110
May	95
June	85
July	117
August	61
September	112
October	65
November	78
December	79

There were thus 412 good entries for January reserved. Of these 412, 22 days gave a S.W. wind. The number 1·66 bears the same proportion to 31 (the number of the days in January) that 22 does to 412; and the value 1·66 is therefore inserted in Table I. as the proper value for the S.W. point in January. The values for each point in each month having been deduced in this way from the first summary, those given to the four cardinal points and their eight adjacents were corrected—the former for defect, the latter for excess. For this purpose the sum of each of the four groups was divided by 3, and the $\frac{1}{3}$ was given to the cardinal point; the remaining quantity was then divided between the two adjacent points of each respective group; and this division was so made that the two values retained the same proportion to one another that they had before. The original summary gives for January 11 days of N. by E., 3 days of N., and 12 days of N. by W. These numbers, reduced to proportionate quantities for 31 days, become N. by E. 0·83, N. 0·23, N. by W. 0·90. The sum of these values divided by 3 gives 0·653 as the adopted value for N. The remainder (1·307) then gives 0·627 and 0·680 as the adopted values for N. by E. and N. by W. respectively; ·627 bearing the same proportion to ·680 that 11 does to 12, or ·83 to ·90. The values thus obtained for the cardinal points and their adjacents are inserted in Table I.; but the cardinals were subdivided for the purpose of giving to each quadrant its due share of the values assigned to the cardinal points, the due share being determined by the relative values of the adjacent points, ·31 being thus given to the eastern half of N., and ·34 to the western half.

Table I. being thus constructed, the sum of all the values given to each month is the same as the number of the days in the month;

and the sum of all the numbers in each line is the number of the days in the year that the wind blows from the point the line belongs to. The column of "means" in this Table shows which of the months exceed, and which are below the year's average for each point. The mean value for the whole Table is 0·95; and the column of means shows that the points N.N.E. to E.N.E. inclusive are above this mean, that E. by N. to S. by W. inclusive are below the mean, that S.S.W. to N.W. inclusive are above, and that N.W. by N. to N. by E. inclusive are below. The arc first specified includes five points, and is on the average ·07 in excess. The second includes eleven points, and is ·43 in defect. The third includes eleven points, and is ·50 in excess. The fourth includes five points, and is ·19 in defect. The diagram shows the relative frequency with which the wind blows from each point during the year.

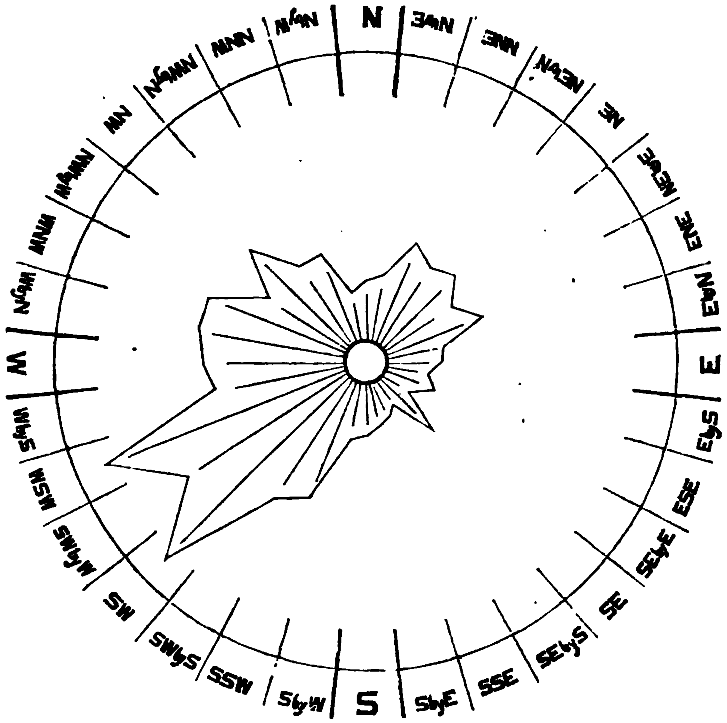

Table II. shows whether the respective values in Table I. are above or below the mean for the line they stand in, the + mark indicating excess, the – mark indicating defect; and where the value is the same as the mean the mark = is introduced.

Table III. gives the *amounts* of the excesses and defects indicated in Table II. The following analysis of the winds will be founded mainly on these three Tables.

Table IV. represents the contents of Table I. in a modified form, which seems good and instructive. This Table is formed upon the *smoothing* principle. Successive triplet values are taken as affording an indication of the normal value belonging to the middle point of the three, and the mean of the three values is inserted in the Table. The Table exhibits the values for the several points, rising and falling with a regularity and consistency beyond what might be expected. This is an important advantage gained, because, if for no other reason, it materially facilitates comparison. The last column (of means) in this Table shows that a very conspicuous maximum occurs at S.W. by W. The values progressively decline at the mean rate ·23 from this maximum to the minimum at S.S.E. They then increase (not quite constantly) to a second maximum at N.E. by N., at the rate ·06. Then they decline at the rate ·13 to N. And then they rise (with one exception) at the rate ·13 to S.W. by W. The minimum value appears at the point S.S.E.; but there is an arc of six points, viz. S. by E. to E.S.E., which may be considered to keep to one level and to constitute an *arc* of minimum value. The mean value for this arc is ·47, and the greatest departure from the mean is only ·05. In each month, with the exception of September alone, S.W. by W. is the point of highest value; in September W. is the highest. The points of lowest value in the separate months are all included in the arc S. by E. to E.S.E. These lowest values are distributed irregularly over the arc, but they incline very much to S.S.E. May, June, August, and September have their lowest values at S.S.E.; July has its lowest at E.S.E.; but this lowest is only ·04 below the value for S.S.E., and the value given by S.S.E. is lower than that given by this point in each of the four months just named; April and December have their lowest values at S. by E., but it would be almost as correct to say S.S.E. instead of S. by E.; so that in seven months S.S.E. is the lowest, or nearly the lowest, in the scale. The secondary maxima are nearly opposite to S.W. by W. in the circle, and they are all included in the arc E. by N. to N. In January the secondary maximum is at E. by N.; in March and September at N.E. by E.; in April at N.E.; in February, May, July, October, and December at N.E. by N.; in June at N.N.E; in August at N. by E.; in November at N. N.E. by N. here preponderates; and this is two points north of the point opposite to S.W. by W. The following arrangement shows the sums and the means of the values for each of these points of secondary high value.

	E. by N.	E.N.E.	N.E. by E.	N.E.	N.E. by N.	N.N.E.	N. by E.	N.
Sums.	0·96	0·00	3·02	1·41	5·47	0·99	0·78	1·19
Means	0·96	0·00	1·51	1·41	1·09	0·99	0·78	1·19

NOTE.—When any amount inserted in this Table as a secondary high value is contributed by one month only, it is repeated in the second line *as a mean value.*

The secondary minima incline very much to the north point, this being two points north of that which is opposite to the point of minimum value. The secondary minimum is in January, February, March, June, July, August, September, October, and December at N.; in April at N. by W.; in May at N.N.W.; in November at N.W. In November the second minimum is not very marked, and N.N.W. is nearly as low in value as N.W.; this arc of low value can therefore scarcely be considered to extend further westward than N.N.W. The arc of lowest values and that of secondary high values are comparatively large. The highest values and the secondary low values have a very small range.

The column for January in Table II. gives two distinct groups of + marks. One of these groups includes the five points S.S.E. to S.S.W. The mean excess for this group, according to Table III., is ·30. The mean of the values for direction, as given in Table I., in this group is ·95; and ·95 is the mean for the whole of the values in Table I. These five points, taking the year through, must therefore be ·30 *below* the general average. The octant (that is to say, the four consecutive points) of greatest excess in this group is S. by E. to S.S.W.; and the mean excess for this octant is ·31. The octant of highest value for direction in the group is the same as that which gives the greatest excess, and the mean value for the direction is 1·02 in this octant. The octant of highest value for direction in the whole column is S.W. to W. by S., the mean value for this being 1·54. The other group of + marks includes the six points E.N.E. to S.E. by E. The mean excess here is ·18, and the mean value for direction is ·79. The octant of greatest excess in this group is E.N.E. to E. by S. The mean excess for the octant is ·23. The octant of highest value for direction is here also the same as that for excess, and the mean value for the direction is ·92. The four points S.W. by S. to W.S.W. constitute a group of — marks. The mean defect for this octant is ·40, and the mean value for direction is 1·45; so that whilst these four points are in January ·40 below their own average value, they are ·50 above the general average. The octant of lowest value for direction in the whole column is E.S.E. to S.E. by S., the mean value for this being ·41. The sum of all the numbers in Table III. for January is 7·10, this being equivalent to 6·87 for thirty days. The values for direction, for the cardinal quadrants, in this month are as follow: N.E. 7·03, S.E. 4·55, S.W. 10·98, N.W. 8·42. If the thirty-one days of this month gave the same proportionate values for the quadrants that the whole year gives, these values would be N.E. 7·24, S.E. 3·98, S.W. 11·33, N.W. 8·50: S.E., therefore, is in excess, and the other three quadrants are somewhat in defect. Seeing that the two groups of excess here noticed have only two points intervening between them, the mean defect for which is ·205, whilst the mean number for the whole column is 2·15, the whole arc E.N.E. to S.S.W. may perhaps be regarded as one of excess; and the mean excess for this arc, which includes two points west of S. and two points north of E., is ·17: the mean for the remaining points is then —·09. Comparing this month with the year, the direction leans much to S. (somewhat westward of S.) and to E.; that is to say, the values for excess come to a maximum at each of these points.

In February the seven points N.E. by N. to E. by S. may be taken as a group of excess, though the one point N.E. by E. has a — mark. The mean excess for this group is ·13, and the mean value for the direction is ·95. This group corresponds with the secondary and more northern group of excess in January, but it occupies a position about two points nearer the north. The octant of greatest excess is E.N.E. to E. by S., the same as in January. The mean excess for the octant is ·18, which is less than the corresponding octant of excess gives in January. The octant of highest value for direction in the group is at its northern extremity, viz. N.E. by N. to E.N.E., the mean value being 1·04. Of the octants S.W. by S. to W.S.W. and W.S.W. to W. by N., each gives the mean value 1·37. The nine points S. to W. form a group of — marks, the mean defect being ·33. The mean value for direction for this group is 1·01. The octant of greatest defect in the group is S.S.W. to S.W. by W., the mean defect being ·55. The octant of lowest value for direction is in the southern extremity of the group, viz. S. to S.W. by S., the mean value for the octant being ·64. The octant of lowest value for direction in the whole column is E.S.E. to S.E. by S., the mean value for this being ·36. The sum of all the numbers for excess and defect is 5·35, which is equivalent to 5·73 for thirty days, this showing a smaller departure from the average distribution of the wind than obtains in January. The values for direction for the cardinal quadrants are N.E. 7·80, S.E. 3·67, S.W. 8·17, N.W. 8·35; and these values, if in accordance with the general averages, would have been N.E. 6·54, S.E. 3·59, S.W. 10·23, N.W. 7·67; so that N.E. is in decided excess, S.W. in considerable defect, and N.W. in moderate excess. Comparing this month with the year, the direction leans to E. and E. by N.

March has one conspicuous group of + marks, and one conspicuous group of — marks. The group of excess includes the seven points N.E. by N. to E. by S., and the same points were named as the arc of excess for February; but the excess in March is by far the greater, the mean excess being ·38; the mean value for direction is 1·20. The octant of greatest excess is at the northern extremity of the group, being N.E. by N. to E.N.E.; the mean excess is ·46. This octant, therefore, is considerably nearer the north than the corresponding octant in February, and the excess is much greater. The octant of highest value for direction also in the group is N.E. by N. to E.N.E., the mean value being 1·45; the column for March contains no other octant of so high a value. The twelve points S.S.W. to N.W. by N. may be taken as a group of defect, though this arc includes W. by N., with an excess of ·08. The mean defect for the group is ·27, and the mean value for direction is 1·13. The octant of greatest defect is S.W. to W. by S., the mean for which is ·54. The octant of lowest value for direction in the group is at its northern extremity, viz. W.N.W. to N.W. by N., the mean value for which is ·95. The octant of lowest value in the whole column is E.S.E. to S.E. by S., the mean for this being ·45. The octant of defect in this month is nearly directly opposite to the octant of excess. The sum of the numbers for excess and defect is 8·04, equivalent to 7·78 for thirty days; this is above the corresponding amounts for the preceding months. The values for the quadrants are N.E. 9·60, S.E. 4·60, S.W. 8·74, N.W. 8·02, instead of 7·24, 3·98, 11·33, and 8·50. This shows a large excess for N.E. and a moderate excess for S.E., a large defect for S.W., and a moderate defect for N.W. The direction leans to E.N.E.

April gives a very long series of + marks: the group (N.N.E. included, which is —·04) consists of fourteen points, viz. N. to S.E. by S. The mean excess for the group is ·20, and the mean value for direction is ·92. The octant of greatest excess is N.E. by N. to E.N.E., the mean excess being ·36. The same octant gives the highest mean value for direction, this being 1·36. This latter arc shows the same characteristics in March, but the values in March are higher in both particulars, though, if the sums for the *groups* of excess are compared, the excess proves to be the greater in April by a small quantity. The octant S.W. by S. to W.S.W. gives the mean value 1·52 for direction. The group of defect includes seven points, viz. S.W. to W.N.W. The mean defect for this group is ·47, and the mean value for direction is 1·12. The octant of greatest defect is W.S.W. to W. by N., the mean defect being ·51. The octant of lowest value for direction in the group is at its northern extremity, viz. W. by S. to W.N.W., the mean value for this being ·77. The octant S.E. by E. to S.S.E. gives the mean value ·51 for direction. The octant of defect is in this month, as in March, nearly opposite to the octant of excess. The sum of the excesses and defects is 8·32, which considerably exceeds the like values for the preceding months. The values for the quadrants are N.E. 9·41, S.E. 4·42, S.W. 8·84, N.W. 7·35, instead of the average values 7·00, 3·85, 10·96, and 8·22. The eastern side of the compass gives the same excess in this month as in March, but N.E. is more in excess, and S.E. less in excess; S.W. is less in defect than in March, and N.W. more in defect. The direction leans to N.E. by N., or to this and N.E.

May gives a well-defined group both of + marks and of — marks. The + marks still keep to north-easterly points. The group includes the six points N. to N.E. by E. The mean excess is ·47, a higher mean for excess than is given by either of the preceding groups; the mean value for direction is 1·39. The arc of excess in this month is much smaller than the corresponding arc in April, through the more southern points of the April group being excluded: the north point forms the northern extreme of the group in each of these months. The mean excess for the group is considerably greater than it is either in March or in April, and the sum of the values for excess in May is greater than in April, although the arc is less: the sum for March is 2·66, for April 2·74, and for May it is 2·85. The mean value for direction for the present group is 1·39, this value having been ·92 in April.

The octant of greatest excess is N. by E. to N.E., this being two points nearer north than the corresponding octant in April; the mean excess for the octant is ·66, whilst in April this is ·36, and in March ·46. The same octant gives the highest mean value for direction in this group, this mean being 1·63. The octant S.W. by S. to W.S.W. gives the mean value 2·07. The group of − marks includes nine points, viz. W. by S. to N. by W.; the northern extremity of this arc, therefore, meets the northern extremity of the group of excess; the north point gives an excess of ·09 only. The mean defect for the group is ·32, the mean value for direction is ·76. The octant of lowest value is at the southern extremity of the group, viz. W. by S. to W.N.W., the mean defect being ·52. The same octant gives the lowest mean value in the group for direction, this mean being ·73. The octant S.E. by S. to S. gives the mean value for direction ·29. The sum for excesses and defects is 9·72, equivalent to 9·41 for thirty days, this being a considerably higher number than that for either of the preceding months. The values for the quadrants are N.E. 9·83, S.E. 3·66, S.W. 11·37, N.W. 6·10, instead of 8·50, 3·98, 11·33, and 7·24. The eastern side of the compass gives nearly the same excess in each of the months March, April, and May; but whilst the value for S.E. progressively diminishes, that for N.E. progressively increases. The value for N.E. increases each month after October; in October it is −1·41, as compared with the average; in November it is −·59; in December −·47; in January −·21; in February +1·26; in March +2·36; in April +2·41; in May +2·59. S.W. in this month rises just above its average value, having been below it each month after October*. The direction leans much to N.N.E. The point of excess progresses northward, as follows: in January it is E. (in the secondary group), February E. by N., March E.N.E., April N.E., May N.N.E. In May, the highest value for excess being at N.N.E., the highest value for defect is at W.N.W., the one being 90° removed from the other.

June shows a great change in the atmospheric movement. Points in the S.W. quadrant are now in excess, and they remain so in the two following months. The five points S.S.W. to W.S.W. make a group of excess, and the mean excess of these is ·69. This is a greater excess than is given by any other of these groups. The mean value for direction is 2·40, and this is a higher value than either of the preceding groups gives. The octant of greatest excess is S.S.W. to S.W. by W., the mean excess being ·79; July and August alone have octants of such great excess. The octant of highest value for direction in this month is S.W. by S. to W.S.W., the mean value for this being 2·59, July and August alone giving so high a value in this respect. Adjoining the group of excess is a series of — values: the fourteen points N.E. to S. by W. form the group of defect, including, however, S.E. by E., which is + ·08, and S.E., which is neutral. The mean defect for the whole group is ·21, and the mean value for direction is ·41. The octant of greatest defect is at the northern extremity of the group, viz. N.E. to E. by N., the mean defect for which is ·40. The octant of lowest value for direction is towards the southern extremity of the group, including S.E. by S. to S., which is the octant of lowest value for the month, and has the mean value ·31. There is only the one point S. by W. intervening between the octant of excess and the octant of defect, and almost directly opposite to the octant of excess there are two points with + marks having the mean value ·16. The sum of the excesses and the defects is 8·73. The values for the quadrants are N.E. 5·55, S.E. 2·84, S.W. 14·19, N.W. 7·45, instead of 7·00, 3·85, 10·96, and 8·22; so that S.W. is now very much in excess, and the other three quadrants are each in defect; N.E. being the most in defect, and S.E. considerably so. The direction leans to S.W. by S., this point giving by far the greatest excess.

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* N.E. keeps steadily above its mean throughout the month; S.W. rises in value during the month, being below the mean at the beginning and above it at the close of the month. (See 'Meteorology of Newport.')

In July the eleven points S.W. by S. to N.W. by N. give + marks. The mean excess for this group is ·67, which is just below the corresponding value for June; but though the mean value is less, the sum is much greater, and this sum is by far greater in this month than the corresponding sum is in any other month. The sums of the excesses increase and diminish with great regularity through the year. The Table below gives, in one column, the sums of the groups of excess, in another the number of points included in each group; and it will be seen that though the values in the latter column are distributed with great irregularity, they are very regular in the former. In constructing this Table, when more than one group of excess appears in a month, that group is taken which contains the greatest number of points if the number of the points varies; when these numbers are the same, the highest sum is taken: in January one group of five points gives the sum 1·50, another of six points gives the sum 1·08.

Months.	Excesses.	Points.
January	1·08	6
February	·91	7
March	2·66	7
April	2·80	14
May	2·82	6
June	3·44	5
July	7·37	11
August	4·64	8
September	3·38	13
October	2·66	14
November	1·98	6
December	1·24	5

The mean value for direction for the group is 2·09. The octant of greatest excess is S.W. to W. by S., the mean excess being 1·06. The octant is two points nearer to W., and further from S. than in June, and it has a value ·27 higher. If the four points S.W. by S. to W.S.W. (the middle points of the common arc) are compared for the two months, the mean for July is ·19 in excess. The same octant (S.W. to W. by S.) gives the highest value for direction in the group; and this is the octant of highest value in the whole year; the mean value is 2·87. All the remaining points in this column may be taken as a group of defect, S.E. alone in this column having a + mark, the value for which is only ·06. The mean defect for the whole group N.N.W. to S.S.W., including twenty-one points, is ·33; and the mean value for direction is ·38. The octant of greatest defect is N.E. by E. to E., the mean defect being ·55. The octant of lowest value for direction is E. to S.E. by E., the mean value being ·19, this being the lowest in the year. The sum for excesses and defects is 14·36, equivalent to 13·90—by much the largest in the year. The values for the quadrants are N.E. 3·56, S.E. 2·08, S.W. 14·92, N.W. 10·44, instead of 7·24, 3·98, 11·33, and 8·50; so that S.W. is still more in excess than it is in June. This value for S.W. is the highest value given by any quadrant in any month; N.W. is also considerably in excess, and N.E. is even more in defect than S.W. is in excess. The direction leans to S.W. by W. and W.S.W.

August, July, and June are very similar as to the arrangement of their + and — marks. Each of these months has a + mark either for S.E. by E. or for S.E. in the midst of a long series of — marks. The columns for July and August consist, almost exclusively, of *one* group of excess and *one* of defect. The group of excess in August has S.W. by S. at one extremity, as in July; but it reaches to W.N.W. only at the other extremity instead of to N.W. by N. as in July, and the excesses are in August lower in amount. The mean excess for the eight points in August is ·58, and the mean value for direction is 2·14. The octant of greatest excess is the southern half of the group, viz. S.W. by S. to W.S.W., the mean value for which is ·82; and the same octant gives the highest mean value for direction in the month, this value being 2·67. The octant of excess is one point nearer south than it is in July, and one point nearer west than it is in June. The remaining twenty-four points have — marks, with the exception of three which are not grouped together, and one of them is of very low amount. The mean defect for the group N.W. by W. to S.S.W. is ·17, and the mean value for direction is ·58. The octant of greatest defect is N.N.E. to N.E. by E., the mean defect being ·45. The octant of lowest value for direction for the month is S.E. by S. to S., the mean value being ·28. The octant of lowest value now oversteps the southern boundary of the S.E. quadrant, whilst in the preceding month the corresponding octant oversteps the eastern boundary. The octant of greatest defect stands nearer to north than it does in the preceding month; and, as in the preceding month, it is only one point removed from the exact opposite to the octant of excess. The sum for excesses and defects is 9·58, equivalent to 9·27. The values for the quadrants are N.E. 5·06, S.E. 2·96, S.W. 14·24, N.W. 8·74, instead of 7·24, 3·98, 11·33, and 8·50. The value for S.W. is decidedly less than in July, the value for N.W. is much less, and that for N.E. is almost as much greater as that for N.W. is less. The direction leans to S.W.

September shows a thorough change in the direction of wind. There is now a long succession of + marks on the eastern side of the compass; and there were some indications of such change taking place in the preceding month. The date of the change may be somewhere about the end of the third week in August, maximum temperature being attained at the very beginning of August in the south of England*. The thirteen points N.E. by N. to S. by E. constitute the group of excess. The mean excess is ·26, and the mean value for direction is ·92, this being just below the mean for the whole Table. The octant of greatest excess is at the northern extreme of the group, viz. N.E. by N. to E.N.E., the mean excess for the octant being ·47. This arc of excess is one point nearer north than that of defect in August. The same octant gives the highest value for direction in the group, the mean being 1·46; but the highest for the month is 1·51 for W.S.W. to W. by N. The six points S. by W. to W.S.W. have – marks. The mean defect for this group is ·43, and the mean value for direction is 1·10. The octant of greatest defect is S.W. by S. to W.S.W., the mean defect being ·57; and this arc is precisely that which gave the greatest excess in August. The octant of lowest value for direction in this group is S. by W. to S.W., the mean value being 1·04; but the lowest value for the month is ·53, for S.E. by S. to S. There are in this month two distinct groups of + marks and two of – marks. The secondary group of + marks comprises only three points, viz. W. and its two proximates; the mean excess for these three points is ·35. The mean value for direction is here 1·58, which exceeds the value given by the octant of excess. The secondary group of – marks embraces an arc of nine points, viz. W.N.W. to N.N.E. The mean defect for the group, which includes one + mark, is ·26, and the mean value for direction is ·69. The octant of greatest defect in this group is W.N.W. to N.W. by N., the mean defect being ·42. The octant of lowest value for direction in this group is N.N.W. to N. by E., the value for this being ·61. The sum for excesses and defects is 9·82. The values for the quadrants are N.E. 8·35, S.E. 5·26, S.W. 8·84, N.W. 7·53, instead of 7·00, 3·85, 10·96, and 8·22; so that S.W. is in considerable defect, and N.E. in decided excess; S.E. is also in very decided excess. The direction leans to N.E. by E.

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* It is shown in 'Meteorology of Newport,' that S.W. winds commence a rapid decline in their daily values on the 24th of August, and that N.E. winds commence a rapid rise on the 21st—also that westerly winds commence a rapid decline on the 23rd, and that easterly winds commence a rapid rise on the 22nd. The thirty days of highest temperature end with August 20, at Newport.

October gives an arc of fourteen points as a group of excess, including S.E. by S., which is ·02 in defect; and it gives an arc of eleven points for a group of defect, including N.W. by N., which is ·03 in excess. The mean excess for the former group, which comprises S.E. by S. to W.N.W., is ·19, and the mean value for direction is 1·33. The octant of greatest excess is at the northern extremity of the group, viz. W. by S. to W.N.W.; the mean excess is ·30. The octant of highest value for direction in the group is the highest for the month also; the mean value is 1·98, for S.W. by S. to W.S.W. The group of defect, which embraces five points on either side of N. extending from N.W. by W. to

N.E. by E., has a mean defect of ·17; and the mean value for direction is ·75. The octant of greatest defect is at the eastern extreme of the group, viz. N.N.E. to N.E. by E., the mean defect being ·28. The octant of lowest value for direction in the group is N. by W. to N.N.E, the mean value being ·63; but the value for E.S.E to S.E. by S. is ·42. The group of defect might here be regarded as a double group; for N. by W. gives the low value —·01, N.N.W. gives —·06, and N.W. by N. gives +·03. In the fall of the year—when decrement of temperature is considerable and the rainfall puts on a new character, being greatly increased in quantity in north latitudes, and being dependent on the change of temperature in the same regions instead of on diversity of temperature in different regions—the groups of excess and of defect become more subdivided and more dispersed. There are seven points as yet unnoticed, viz. E.N.E. to S.E.; the four most northern of these are in excess to a small extent, excepting E. by N., which is neutral; the three southern points are in defect, and E.S.E. is so much as ·35 in defect. The sum for excesses and defects is 5·30, equivalent to 5·13—the lowest of such sums. The values for the quadrants are N.E. 5·83, S.E. 3·86, S.W. 12·37, N.W. 8·96, instead of 7·24, 3·98, 11·33, and 8·50. There is therefore in this month a partial return to the conditions of the summer months shown by N.E., S.E., and S.W. The S.W. quadrant reaches a very high value on October 4, and keeps above its mean from September 24 to October 11, and again from October 20 to October 28. The highest value for rainfall occurs on October 3, at Newport, and the lowest value for atmospheric pressure occurs on October 4; and October is the month that gives the greatest amount of rain*. Does the direction of the wind cause the abundant rainfall? or does the rainfall cause the direction of the wind? If the rainfall is to be attributed to the direction of the wind rather than the wind to the rainfall, we ought then to expect a check to the decrement of temperature to be apparent; but this is not so; the temperature for October is 6°·7 below that for September, whilst September temperature is only 3°·4 below that for August, and November is 6°·2 below October; the difference between September temperature and October temperature is greater than that for any other two consecutive months. The direction leans to W.N.W. and W. by N.

The column for November is broken into six groups—three of excess and three of defect, one in each category being of small account. The group S. by E. to S. by W. is one of considerable excess, the mean excess for these three points being ·52; and the mean value for direction is 1·07. The group N.W. to N. by E., consisting of six points, has a mean excess of ·33, the sum for the six points much exceeding that for the three points. The mean value for direction for the six points is 1·18. The octant of greatest excess in this group is N.N.W. to N. by E., the mean excess being ·41. The octant of highest value for direction in the group is N.W. to N. by W., the mean value being 1·22; but the octant S.W. to W. by S. gives 1·55. The group E. by N. to E. by S. has a mean excess of ·16. The principal group of defect (that of greatest defect) is N.N.E. to E.N.E.; this group of five points has a mean defect of ·28; and the mean value for direction is ·73. The octant of greatest defect is N.E. by N. to E.N.E., the mean defect being ·31; the same octant gives the lowest value for direction in this group, this being ·69; but S.E. by E. to S.S.E. gives ·28. The secondary group of defect is one of ten points, viz. S.S.W. to N.W. by W., including W. by S., with an excess of ·09. The sum for this group greatly exceeds the sum for the preceding group of defect, but the mean defect is ·24; the mean value for direction is 1·22. The octant of greatest defect in this group is S.W. by S. to W.S.W., the mean defect being ·45. The octant of lowest value for direction in this group is W. to N.W. by W., the mean value being 1·06. The group of five points E.S.E. to S.S.E. has a mean defect of ·15, including + ·04 for S.E. by S. The value for direction is singularly high in this month for N. and N. by W., also for S. and S. by E. The northern group of excess in this month, of secondary mean value, has a higher mean value than the octant of greatest excess in October, and the defects are also of course greater. S.W. by S. and S.W. are in great defect; so also are N.E. by N. and N.E. by E. The sum for excesses and defects is 8·88—a considerable increase upon that for the preceding month. The values for the quadrants are N.E. 6·41, S.E. 4·17, S.W. 10·11, N.W. 9·23, instead of 7·00, 3·85, 10·96, and 8·22—a distribution very different from that of the preceding month, and corresponding very much with that of December and January; but whilst N.W. gives in November a greater excess than in any other month except July, January shows a small defect for this quadrant. November differs greatly from the three spring months in showing a defect for N.E., whilst the spring shows a great excess, and in showing a great excess for N.W., whilst the spring shows a large defect. November differs from the three summer months in showing a defect for N.E. very much less than that in the summer, and a defect for S.W., this quadrant being greatly in excess in the summer. The direction leans to N. by W.

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* See 'Meteorology of Newport.'

In December the + marks and the – marks are very much intermixed, but groups of excess and of defect may be detected by taking their mean values as characteristics. The five points N.N.W. to N.N.E. constitute a group of excess, the mean excess for which is ·25—the excess for the N.N.W. point being great, and that for the N.N.E. point greater. The mean value for direction for this group is 1·05. The seven points S. by E. to S.W. by W. constitute a group of defect, the mean defect for which is ·10; S.W. in the group is greatly in defect. The mean value for direction for this group is 1·05. The sum for excesses and defects is 6·11, equivalent to 5·91. The values for the quadrants are N.E. 6·77, S.E. 4·09, S.W. 10·63, N.W. 9·46, instead of 7·24, 3·98, 11·33, and 8·50. The direction leans to N. by W.

The three months June, July, and August constitute a period marked with special characteristics, similar conditions being observable in each of these months. The arc which embraces the six points S.S.W. to W. by S. includes the octants of excess for each of these months. The mean values for the three months, for each of these points, are as follows: S.S.W.—·12, S.W. by S.+·38, S.W.+·91, S.W. by W.+1·13, W.S.W.+·90, W. by S.+·26; so that the excess increases progressively in this order to S.W. by W., and then progressively diminishes. If successive triplets are taken, the name of the middle point being given to the mean excess of the triplet, the excesses stand then as follow:—

	S.W. by S.	S.W.	S.W. by W.	W.S.W.
June	0·52	0·89	0·93	0·60
July	0·22	0·73	1·23	1·06
August	0·44	0·79	0·78	0·62
Means......	0·39	0·80	0·98	0·76

The two more westerly points here give in each month a higher value than that of the two more southerly points. S.W. by W., according to this showing, is very markedly the point of greatest excess in this quarter of the year. The arc embracing the six points N.N.E. to E. by N. includes the octant of defect for each of these months. The mean three-month values for defect for each of the six points, which stand precisely opposite to those of the former category, are as follow: N.N.E. ·16, N.E. by N. ·36, N.E. ·41, N.E. by E. ·46, E.N.E. ·46, E. by N. ·32. The triplet grouping gives the following results:—

	N.E. by N.	N.E.	N.E. by E.	E.N.E.
June	0·10	0·28	0·45	0·33
July	0·38	0·45	0·57	0·61
August	0·44	0·49	0·30	0·30
Means......	0·31	0·41	0·44	0·41

N.E. by E., therefore, is most in defect in these months, this point of defect being precisely opposite to the point of excess before noticed. The point that gives the lowest value for direction, under the triplet grouping, for this quarter is S.S.E.; the value thus obtained for the quarter is ·25, the value for the year being ·42. August has somewhat of a transitional character as between July and September. The octant of excess in August has an intermediate value; the octant of defect has a lower value than that for July. If a group be made of the eight highest consecutive numbers in Table III., the amount for such octave will be found much lower in August than in July. There is an appearance of wavering in August; the direction is not so confined to a small arc; each quadrant approaches nearer to its average value; and whilst the approximation is still closer in September, the departures from the averages in this month obtain in a contrary sense. In September the eastern quadrants are both above the average values, and the western are below. In August the eastern quadrants are less below the averages than they are in July, and the western are less above.

In September N.E. by E. becomes the point of greatest excess; it is such both in its individual and triplet value. W. is the point that gives the highest value for direction; but this value is only ·03 above that for N.E. by E. The point of greatest defect is, in this month, S.W. by W. under the triplet grouping, but W.S.W. gives the greatest defect singly. It is easy perhaps to account, to a certain extent, for the atmospheric movements in these four months. It seems evident that the movement, in the first instance, is attributable to the high and increasing temperature prevailing at that period of the year, and that it is attributable in the last instance to the decline of temperature that then ensues. It is perhaps a mere matter of course that all such atmospheric movements are dependent somehow upon temperature; but it is a step gained to be able to say precisely what the nature of the movement actually is, what the changes in the direction are, and to connect these, so far as has been done, with the progress of temperature. How far and at what periods temperature controls the wind *directly* by lowering the density of the atmosphere in some regions and raising it in others; how and when it influences direction *indirectly* by increasing the quantity of one of the atmospheric constituents (*i. e.* the vapour) in some regions, and by reducing the quantity of the same constituent in other regions; how far the influence of temperature is determined by the varying nature and conformation of the terrestrial surface in different regions, we are as yet quite unable to say; but no doubt each of these agencies is continually in action, and probably each, in turn, exercises the *main* control. A great deal must yet be done, not merely in collecting but in arranging facts, before the complete succession of causes and effects can be traced. The first thing, however, is to ascertain what the wind itself *is about*; and if this be determined for one spot it may hereafter be determined for others also: this would make a very important addition to our knowledge in these matters.

October shows a return to the more ordinary conditions of wind. The directions are in some respects less localized than they are in September, as has already been shown. The westerly winds tend considerably, in this month, to the N.W. quadrant; the octant of excess reaches from W. by S. to W.N.W.; in December the octant of excess reaches from the east side of N. to N. by W.; and in no other month does the octant of excess include any north-westerly point. Deposition seems to be the controlling agent now; and it is to be supposed that the site of the deposition would not be the same in this season of rapidly declining temperature as it is in the season of increasing temperature.

In November the arc of greatest excess is small, but the excess is great. The directions are remarkable for leaning so much to north and south, instead of east and west. The decline of temperature is rapid at the commencement of this month, but it entirely subsides by the end of the month. Abundant deposition would tend to check decrement in temperature; and it might have great effect in equalizing temperature in different longitudes, but great differences in temperature might obtain in different latitudes. These north winds may consequently depend on different densities; or they may result from deposition being transferred to more northern and colder regions, the atmosphere flowing back southward after accumulating at the site of deposition; and the southerly winds would constitute the primary current flowing *to* the site of deposition, to occupy the void made by the deposition. An explanation of the unusual tendency to S. and S. by E. (instead of south-west) winds in this month, may be found in the calm state of the atmosphere. If the atmosphere move slowly from the south, it will not retain the eastward impulse given to it in the lower latitudes as it progresses northward; the atmosphere coming from S. arrives consequently as a S. wind. The force of wind, as appeared from a few years' record, is considerably less in November than in any other month.

December has its directions distributed very much in accordance with the general averages. It appears from this that no one influence preponderates. The rainfall is close upon the average quantity, and the value given for the force of wind is just the mean value for the year.

In January the directions appear less conformable to the general rule than in December; the directions converge more to particular points, small arcs thus showing greater departures from their means; but although this is the case with small arcs, the quadrants, nevertheless, come very close to the average values. The quadrants deviate most from the average standard in July, and they approach nearer to this standard each month after this to January, the smallest deviation appearing in this month. It may appear from this that the special circumstances causing the convergence are very local, whilst the more general control is such as most commonly prevails through the year. It is probable that at other sites, not very distant, it would be found that January, instead of December, gives the directions most in accordance with the general averages. The value for the N.E. quadrant is below the average in this and in the three preceding months; but the defect diminishes in each month after October, and in February this quadrant is in excess. The N.W. quadrant is in defect in January, and it is in excess in the three preceding months. It would seem that the north-west winds belong more especially to the rainy season, but they do not *accompany* the rain.

In February that reversed order is clearly pronounced which may be seen to be approaching in the preceding months. The values for the quadrants now depart greatly from the averages; the N.E. quadrant is in considerable excess, and the S.W. quadrant is in considerable defect. The octant of excess is, for the most part, on the north side of E. The octant of defect is in the S.W. quadrant, and the defect is great. The rainfall is less in this month than in December or January. Temperature attains its minimum early in February at Newport, and early in January at Greenwich; and small progress is made in temperature at either of these places between these two dates of minimum temperature.

In March the north-east tendency is strongly developed*. This month may be grouped with the two following as partaking of the same marked character. The arc E.N.E. to N. by E. includes the octant of excess for each of these three months. The mean values for excess for each of the six points, for the three months, are as follows:—N. by E. ·35, N.N.E. ·30, N.E. by N. ·40, N.E. ·56, N.E. by E. ·28, E.N.E. ·29. N.E. here gives the greatest excess, and N.E. by N. the next greatest. The triplet grouping of the individual values for excess gives the following results:—

	N.N.E.	N.E. by N.	N.E.	N.E. by E.
March	0·18	0·23	0·40	0·46
April	0·30	0·29	0·41	0·32
May	0·57	0·73	0·42	0·35
Means......	0·35	0·42	0·41	0·38

The values for the two more northerly points almost exactly balance those for the two more easterly points on the whole; but in March they increase from north to south, and in May they increase from south to north. The excess in this quarter of the year appears to be equally divided between N.E. and N.E. by N. The highest value for direction in this quarter, when determined by the triplet grouping, belongs to S.W. by W. as well as in the summer quarter; the next highest value belongs to N.E. by N., the mean value for S.W. by W. being 1·81, and that for N.E. by N. 1·45, whilst in the summer quarter N.E. by N. and N.E. each give ·73. Taken singly, the S.W. and N.E. points give the highest mean values for these months, S.W. giving 2·22 and N.E. 1·63.

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* The N.E. becomes the prevailing quadrant on February 27, having been less frequent than the other quadrants after September 15, with the exception of three days in February. See 'Meteorology of Newport.'

It would appear that in this quarter the excess proceeds from a region just opposite to that which gives the excess in the summer quarter; but the rotation of the earth gives an eastern bias to the north-eastern current, and a western bias to the south-western current. March and April give less rain than any other month; and March, April, and May together give less than any other three months, the three next lowest being February, June, and July. Low temperature in northerly or north-easterly regions seems to produce the north-east excess through the difference in the densities of the atmosphere in the north-east and south-west during this season of rapidly rising temperature. The arc S.W. to W.N.W. includes the octants of defect for these three months. The mean values for defect for these seven points are S.W. ·07, S.W. by W. ·39, W.S.W. ·25, W. by S. ·48, W. ·42, W. by N. ·37, W.N.W. ·32. The triplet grouping gives the following results:—

	S.W. by W.	W.S.W.	W. by S.	W.	W. by N.
March ...	0·55	0·58	0·46	0·21	0·07
April	0·45	0·45	0·45	0·55	0·51
May	+0·30	0·09	0·23	0·51	0·53
Means..	−0·23	0·37	0·38	0·42	0·37

W. is shown to be the point of greatest defect; and W. is the point of highest value for direction, under the triplet grouping, in September, though in all other months S.W. by W. is so; but W. is not the point of greatest *excess* in September. The south-west arc of excess (as at present referred to) in summer gives a greater excess than the north-east arc of excess in the spring, in the proportion 3·80 to 2·18; the north-east arc of defect in summer gives a less defect than the west arc of defect in the spring, as 2·17 to 2·30. The excess for the S.W. quadrant in summer exceeds the excess for the N.E. quadrant in spring as 9·73 to 7·36; but the defect for the N.E. quadrant in summer exceeds the defect for the S.W. quadrant in spring as 7·31 to 4·67. The tendency therefore of the wind to keep to the specified arc of excess in the summer is a very prominent fact; the converging tendency is very strong. The wind's aversion from the N.E. *quadrant* in the summer is also very conspicuous.

TABLE I. Directions of Wind.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sums.	Means.
N.	0·65	0·66	0·75	0·81	0·75	0·35	0·36	0·61	0·57	0·56	1·19	0·71	7·97	0·66
N. by E.	0·63	0·75	0·97	1·19	1·21	0·61	0·44	0·95	0·33	0·55	1·02	0·57	9·22	0·77
N.N.E.	0·83	0·95	0·97	1·05	2·14	1·37	0·65	0·78	0·90	0·86	0·90	1·71	13·11	1·09
N.E. by N.	1·20	1·09	1·42	1·46	1·16	0·99	0·49	0·29	1·22	0·94	0·52	0·67	11·45	0·95
N.E.	0·83	1·24	1·42	1·46	2·01	0·46	0·82	0·71	1·22	0·86	1·04	0·82	12·89	1·07
N.E. by E.	0·75	0·80	1·34	1·30	1·08	0·68	0·33	0·50	1·87	0·29	0·52	0·89	10·35	0·96
E.N.E.	1·13	1·02	1·64	1·22	1·00	0·53	0·16	0·93	1·55	1·08	0·67	1·04	11·97	1·00
E. by N.	0·90	1·05	0·90	0·76	0·41	0·41	0·30	0·29	0·73	0·65	0·82	0·52	7·74	0·65
E.	0·85	0·82	0·86	0·68	0·31	0·30	0·19	0·33	0·76	0·64	0·75	0·52	7·01	0·58
E. by S.	0·80	0·61	0·82	0·59	0·21	0·20	0·08	0·38	0·79	0·65	0·67	0·52	6·32	0·53
E.S.E.	0·60	0·36	0·45	0·65	1·08	0·46	0·49	0·50	0·73	0·22	0·45	0·82	6·81	0·57
S.E. by E.	0·45	0·15	0·45	0·41	0·23	0·38	0·00	0·43	0·49	0·29	0·15	0·22	3·65	0·30
S.E.	0·30	0·58	0·75	0·81	1·08	0·68	0·74	0·57	0·98	0·58	0·37	0·74	8·18	0·68
S.E. by S.	0·30	0·36	0·15	0·49	0·31	0·23	0·16	0·14	0·41	0·58	0·37	0·45	3·95	0·33
S.S.E.	0·68	0·58	0·90	0·32	0·23	0·30	0·41	0·21	0·57	0·43	0·22	0·52	5·37	0·45
S. by E.	0·68	0·49	0·45	0·57	0·28	0·33	0·11	0·36	0·60	0·53	1·07	0·37	5·84	0·49
S.	0·75	0·41	0·59	0·54	0·36	0·38	0·24	0·41	0·54	0·74	1·06	0·45	6·47	0·54
S. by W.	0·83	0·34	0·75	0·51	0·44	0·43	0·38	0·45	0·49	0·96	1·07	0·52	7·17	0·60
S.S.W.	1·81	0·66	1·12	0·97	1·55	1·67	0·74	0·78	0·98	1·22	1·12	1·49	14·11	1·18
S.W. by S.	1·05	1·17	1·12	1·30	1·24	1·44	1·31	2·21	1·06	1·29	0·60	1·41	15·20	1·27
S.W.	1·66	1·82	1·87	1·86	2·94	3·19	3·35	3·06	1·63	2·52	1·79	1·78	27·47	2·29
S.W. by W.	1·35	0·58	1·12	1·14	1·62	3·29	2·78	2·35	1·14	1·80	1·64	1·34	20·15	1·68
W.S.W.	1·73	1·90	1·49	1·78	2·47	2·43	3·68	3·06	1·30	2·30	1·57	2·16	25·87	2·16
W. by S.	1·43	1·02	0·60	0·68	0·59	1·01	1·66	1·40	1·33	1·20	1·19	1·11	13·22	1·10
W.	1·32	1·19	1·02	0·68	0·73	1·19	1·58	1·52	1·58	1·46	1·10	1·41	14·78	1·23
W. by N.	1·23	1·36	1·44	0·68	0·85	1·37	1·50	1·64	1·82	1·73	0·99	1·71	16·32	1·36
W.N.W.	1·73	1·31	1·27	1·05	0·77	1·22	2·29	1·85	0·49	1·87	1·34	1·04	16·23	1·35
N.W. by W.	0·90	1·02	0·67	1·22	0·77	0·61	1·64	0·93	0·90	0·72	0·82	1·26	11·46	0·95
N.W.	1·35	1·17	0·97	2·03	1·31	1·37	1·97	1·21	0·73	1·15	1·42	1·19	15·87	1·32
N.W. by N.	0·75	0·95	0·90	0·89	0·70	1·14	1·23	0·86	0·73	0·94	1·14	0·74	10·97	0·91
N.N.W.	0·83	1·02	1·27	0·49	0·85	0·91	0·65	1·00	0·73	0·86	0·97	1·41	10·99	0·92
N. by W.	0·68	0·56	0·52	0·43	0·28	0·10	0·27	0·29	0·81	0·55	1·37	0·84	6·70	0·56

TABLE II. Individual Directions compared with Mean Directions.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
N.	−	−	+	+	+	−	−	−	−	−	+	+
N. by E.	−	−	+	+	+	−	−	+	−	−	+	−
N.N.E.	−	−	−	−	+	+	−	−	−	−	−	+
N.E. by N.	+	+	+	+	+	+	−	−	+	−	−	−
N.E.	−	+	+	+	+	−	−	−	+	−	−	−
N.E. by E.	−	−	+	+	+	−	−	−	+	−	−	−
E.N.E.	+	+	+	+	−	−	−	−	+	+	−	+
E. by N.	+	+	+	+	−	−	−	−	+	−	+	−
E.	+	+	+	+	−	−	−	−	+	+	+	−
E. by S.	+	+	+	+	−	−	−	−	+	+	+	−
E.S.E.	+	−	−	+	+	−	−	−	+	−	−	+
S.E. by E.	+	−	+	+	−	+	−	+	+	−	−	−
S.E.	−	−	+	+	+	−	+	−	+	−	−	+
S.E. by S.	−	+	−	+	−	−	−	−	+	+	+	+
S.S.E.	+	+	+	−	−	−	−	−	+	−	−	+
S. by E.	+	−	−	+	−	−	−	−	+	+	+	−
S.	+	−	+	−	−	−	−	−	−	+	+	−
S. by W.	+	−	+	−	−	−	−	−	−	+	+	−
S.S.W.	+	−	−	−	+	+	−	−	−	+	−	+
S.W. by S.	−	−	−	+	−	+	+	+	−	+	−	+
S.W.	−	−	−	−	+	+	+	+	−	+	−	−
S.W. by W.	−	−	−	−	−	+	+	+	−	+	−	−
W.S.W.	−	−	−	−	+	+	+	+	−	+	−	−
W. by S.	+	−	−	−	−	−	+	+	+	+	+	+
W.	+	−	−	−	−	−	+	+	+	+	−	+
W. by N.	−	−	+	−	−	+	+	+	+	+	−	+
W.N.W.	+	−	−	−	−	−	+	+	−	+	−	−
N.W. by W.	−	+	−	+	−	−	+	−	−	−	−	+
N.W.	+	−	−	+	−	+	+	−	−	−	+	−
N.W. by N.	−	+	−	−	−	+	+	−	−	+	+	−
N.N.W.	−	+	+	−	−	−	−	+	−	−	+	+
N. by W.	+	−	−	−	−	−	−	−	+	−	+	+

TABLE III. Amounts of Departures from Means.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
N.	·01	·00	·09	·15	·09	·31	·30	·05	·09	·10	·53	·05
N. by E.	·14	·02	·20	·42	·44	·16	·33	·18	·44	·22	·25	·20
N.N.E.	·26	·14	·12	·04	1·05	·28	·44	·31	·19	·23	·19	·62
N.E. by N.	·25	·14	·47	·51	·21	·04	·46	·66	·27	·01	·43	·28
N.E.	·24	·17	·35	·39	·94	·61	·25	·36	·15	·21	·03	·25
N.E. by E.	·21	·16	·38	·34	·12	·28	·63	·46	·91	·67	·44	·07
E.N.E.	·13	·02	·64	·22	·00	·47	·84	·07	·55	·08	·33	·04
E. by N.	·25	·40	·25	·11	·24	·24	·35	·36	·08	·00	·17	·13
E.	·27	·24	·28	·10	·27	·28	·39	·25	·18	·06	·17	·06
E. by S.	·27	·08	·29	·06	·32	·33	·45	·15	·26	·12	·14	·01
E.S.E.	·03	·21	·12	·08	·51	·11	·08	·07	·16	·35	·12	·25
S.E. by E.	·15	·15	·15	·11	·07	·08	·30	·13	·19	·01	·15	·08
S.E.	·38	·10	·07	·13	·40	·00	·06	·11	·30	·10	·31	·06
S.E. by S.	·03	·03	·18	·16	·02	·10	·17	·19	·08	·25	·04	·12
S.S.E.	·23	·13	·45	·13	·22	·15	·04	·24	·12	·02	·23	·07
S. by E.	·19	·00	·04	·08	·21	·16	·38	·13	·11	·04	·58	·12
S.	·21	·13	·05	·10	·18	·16	·30	·13	·00	·20	·52	·09
S. by W.	·23	·26	·15	·09	·16	·17	·22	·15	·11	·36	·47	·08
S.S.W.	·63	·52	·06	·21	·37	·49	·44	·40	·20	·04	·06	·31
S.W. by S.	·22	·10	·15	·03	·03	·17	·04	·94	·21	·02	·67	·14
S.W.	·63	·47	·42	·43	·65	·90	1·06	·77	·66	·23	·50	·51
S.W. by W.	·33	1·10	·56	·54	·06	1·61	1·10	·67	·54	·12	·04	·34
W.S.W.	·43	·26	·67	·38	·31	·27	1·52	·90	·86	·14	·59	·00
W. by S.	·33	·08	·50	·42	·51	·09	·56	·30	·23	·10	·09	·01
W.	·09	·04	·21	·55	·50	·04	·35	·29	·35	·23	·13	·18
W. by N.	·13	·00	·08	·68	·51	·01	·14	·28	·46	·37	·37	·35
W.N.W.	·38	·04	·08	·30	·58	·13	·94	·50	·86	·52	·01	·31
N.W. by W.	·05	·07	·28	·27	·18	·34	·69	·02	·05	·23	·13	·31
N.W.	·03	·15	·35	·71	·01	·05	·65	·11	·59	·17	·10	·13
N.W. by N.	·16	·04	·01	·02	·21	·23	·32	·05	·18	·03	·23	·17
N.N.W.	·09	·10	·35	·43	·07	·01	·27	·08	·19	·06	·05	·49
N. by W.	·12	·00	·04	·13	·28	·46	·29	·27	·25	·01	·81	·28

TABLE IV. Values for Direction smoothed by Triplet Meaning.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Means.
N.	0·65	0·66	0·75	0·81	0·75	0·35	0·36	0·62	0·57	0·55	1·19	0·71	0·66
N. by E.	0·70	0·79	0·90	1·02	1·37	0·78	0·48	0·78	0·60	0·66	1·04	1·00	0·84
N.N.E.	0·89	0·93	1·12	1·23	1·50	0·99	0·53	0·67	0·82	0·78	0·81	0·98	0·94
N.E. by N.	0·95	1·09	1·27	1·32	1·77	0·94	0·65	0·59	1·11	0·89	0·82	1·07	1·04
N.E.	0·93	1·04	1·39	1·41	1·42	0·71	0·55	0·50	1·44	0·70	0·69	0·79	0·96
N.E. by E.	0·90	1·02	1·47	1·33	1·36	0·56	0·44	0·71	1·55	0·74	0·74	0·92	0·98
E.N.E.	0·93	0·96	1·29	1·09	0·83	0·54	0·26	0·57	1·38	0·67	0·67	0·82	0·83
E. by N.	0·96	0·96	1·13	0·89	0·57	0·41	0·22	0·52	1·01	0·79	0·75	0·69	0·74
E.	0·85	0·83	0·86	0·68	0·31	0·30	0·19	0·33	0·76	0·65	0·75	0·52	0·59
E. by S.	0·75	0·60	0·71	0·64	0·53	0·32	0·25	0·40	0·76	0·50	0·62	0·62	0·56
E.S.E.	0·62	0·37	0·57	0·55	0·51	0·35	0·19	0·44	0·67	0·39	0·42	0·52	0·47
S.E. by E.	0·45	0·36	0·55	0·62	0·80	0·51	0·41	0·50	0·73	0·36	0·32	0·59	0·52
S.E.	0·35	0·36	0·45	0·57	0·54	0·43	0·30	0·38	0·63	0·48	0·30	0·47	0·44
S.E. by S.	0·43	0·51	0·60	0·54	0·54	0·40	0·44	0·31	0·65	0·53	0·32	0·57	0·49
S.S.E.	0·55	0·48	0·50	0·46	0·27	0·29	0·23	0·24	0·53	0·51	0·55	0·45	0·42
S. by E.	0·70	0·49	0·65	0·44	0·29	0·34	0·25	0·33	0·57	0·57	0·78	0·45	0·49
S.	0·75	0·41	0·60	0·51	0·36	0·38	0·24	0·41	0·54	0·74	1·07	0·45	0·54
S. by W.	1·13	0·47	0·82	0·64	0·78	0·83	0·45	0·55	0·67	0·97	1·08	0·82	0·77
S.S.W.	1·23	0·72	1·00	0·93	1·08	1·18	0·81	1·15	0·84	1·16	0·93	1·14	1·01
S.W. by S.	1·51	1·22	1·37	1·38	1·91	2·10	1·80	2·02	1·22	1·68	1·17	1·56	1·58
S.W.	1·35	1·19	1·37	1·43	1·93	2·64	2·48	2·54	1·28	1·87	1·34	1·51	1·74
S.W. by W.	1·58	1·43	1·49	1·59	2·34	2·97	3·27	2·82	1·36	2·21	1·67	1·76	2·04
W.S.W.	1·50	1·17	1·07	1·20	1·56	2·24	2·71	2·27	1·26	1·77	1·47	1·54	1·65
W. by S.	1·49	1·37	1·04	1·05	1·26	1·54	2·31	1·99	1·40	1·65	1·29	1·56	1·50
W.	1·33	1·19	1·02	0·68	0·72	1·19	1·58	1·52	1·58	1·46	1·09	1·41	1·23
W. by N.	1·43	1·29	1·24	0·80	0·78	1·26	1·79	1·67	1·30	1·69	1·14	1·39	1·31
W.N.W.	1·29	1·23	1·13	0·98	0·80	1·07	1·81	1·47	1·07	1·44	1·05	1·34	1·22
N.W. by W.	1·33	1·17	0·97	1·43	0·95	1·07	1·97	1·33	0·71	1·25	1·19	1·16	1·21
N.W.	1·00	1·05	0·85	1·38	0·93	1·04	1·61	1·00	0·79	0·94	1·13	1·06	1·07
N.W. by N.	0·98	1·05	1·05	1·14	0·95	1·14	1·28	1·02	0·73	0·98	1·18	1·11	1·05
N.N.W.	0·75	0·84	0·90	0·60	0·61	0·72	0·72	0·72	0·76	0·78	1·16	1·00	0·80
N. by W.	0·72	0·75	0·85	0·58	0·63	0·45	0·43	0·63	0·70	0·66	1·18	0·99	0·71

Table V. Showing the number of days the Wind is within the limits of each Cardinal Quadrant in each of the Months.

Months.	N.E.	S.E.	S.W.	N.W.
January	7·03	4·55	10·98	8·42
February	7·80	3·67	8·17	8·35
March	9·60	4·60	8·74	8·02
April	9·41	4·42	8·84	7·35
May	9·83	3·66	11·37	6·10
June	5·55	2·84	14·19	7·45
July	3·56	2·08	14·92	10·44
August	5·06	2·96	14·24	8·74
September	8·35	5·26	8·84	7·53
October	5·83	3·86	12·37	8·96
November	6·41	4·17	10·11	9·23
December	6·77	4·09	10·63	9·46

Table VI. Showing the amount to which each value in Table V. exceeds or falls short of the yearly mean of the column the value stands in, regard being had to the number of the days given to each month. The numbers in the last column of this Table are the sums of the numbers in the line each stands on.

Months.	N.E.	S.E.	S.W.	N.W.	
January	−0·21	+0·57	−0·35	−0·08	1·21
February	+1·26	+0·08	−2·06	+0·68	4·08
March	+2·36	+0·62	−2·59	−0·48	6·05
April	+2·41	+0·57	−2·12	−0·87	5·97
May	+2·59	−0·32	+0·04	−2·40	5·35
June	−1·45	−1·01	+3·23	−0·77	6·46
July	−3·68	−1·90	+3·59	+1·94	11·11
August	−2·18	−1·02	+2·91	+0·24	6·35
September	+1·35	+1·41	−2·12	−0·69	5·57
October	−1·41	−0·12	+1·04	+0·46	3·03
November	−0·59	+0·32	−0·85	+1·01	2·77
December	−0·47	+0·11	−0·70	+0·96	2·24

CXIX. *On Rain-Gauges.* By R. Strachan, Esq.

The subject of the best form of rain-gauge has occupied much attention during the last two or three years, in consequence of the very great interest taken by a large number of persons in observing the rainfall; but it does not appear that any decision is likely, for some time, to be arrived at by those considered the most experienced. Common sense would lead one to suppose that the matter was extremely simple, and had long ago been settled for ever.

Weather-observers of days gone by considered the rain-gauge the simplest of meteorological instruments; and who can prove that their records of the rainfall are not as reliable as the most recent? I believe that the question has been decided as well as it need be, and that making it so long a matter of doubt does not tend to improve the accuracy of observation, or advance meteorological science. To increase observers to a needless extent, it has been found desirable to encourage cheapness of production; and to obtain this it was necessary to resort to a small-size gauge. Nothing is more prejudicial to a science of observation, like meteorology, than diversity in the employment of instruments, as regards material, form, size, &c.; and this conclusion especially forces itself upon the attention of any one who investigates the statistics of rainfall. In no other meteorological instrument is variety in form, size, make, material, and principle of measurement likely to be so objectionable as in the rain-gauge. It is to this that must be attributed the astonishing discrepancies between the amount of rain observed by different persons in the same locality. They cannot be imputed to difference of position and exposure, while there is no uniformity in the character of the gauges employed, and while no wish is even expressed by meteorologists to attain so desirable a system.

At the last two Meetings of the Society, Mr. Symons called attention to rain-gauges, and at the former (21st of February), Mr. Casella, the well-known optician, requested, with marked distinctness, to be informed what size and form of gauge was considered best. Mr. Symons, who professes to have been experimenting, investigating, and observing for many years, absolutely declined to give a definite answer. All he said amounted to this: —"Mr. Glaisher adopted for his gauge a receiving aperture 8 inches in diameter, the Scottish Meteorological Society recommend a gauge only 2 inches in diameter, I meet both halfway and recommend a gauge 5 inches in diameter." This is a "lame and impotent conclusion," even if it were accurate. The area of the receiving aperture ought to be the subject of comparison, and since the areas of circles vary as the squares of the diameters, it is evident that he has not taken a mean size.

Mr. Glaisher was equally reticent, but (on 21st of March) he stated truly that the first division on nearly all measuring-glasses was generally very inaccurately placed and gave less than it should. I can corroborate this assertion; for I have seen glasses made to measure hundredths of an inch on which the first division was not even shown. Glaisher's rain-gauge has been before the public about a quarter of a century, and it had become the general opinion that for ordinary work it was all that could be desired; yet, strange to say, its inventor had nothing to say in its defence. One would have thought that it was the result of experiment and experience, and that its diameter at least had not been selected at random. Of course numerous trials led Mr. Glaisher to adopt the gauge which he used to recommend; then why does he not defend his own invention? There is no other size or principle of rain-gauge so useful or more accurate. The distribution about the country of little pipkin-like things for the serious purpose of scientific observation ought surely to be discouraged.

The diameter of the gauge and the graduation of the glass measure being made to calculation, any departure from accuracy in either or both must render the result (the measurement of the rain) erroneous, unless the error in the one compensates for that in the other. Now, the aperture of the gauge having been turned in a lathe by an ordinary workman using a common inch measure, is more likely to be defective in accuracy than the glass measure which is made by a workman having an engine divider and an accurate scale of inches. It is also quite as probable that the same amount of error will be made in turning a 2-inch as in turning an 8-inch circle. At any rate, if we suppose this, a little calculation will show that the results obtained from the very small gauges cannot be considered so reliable as those from larger.

Let $x =$ diameter of gauge,
$c =$ the constant ·7854,
$u =$ area of aperture.

Then $$x^2c = u,$$

and $$du = 2cx \,.\, dx.$$

Let the error in measuring the diameter be ·05 of an inch in excess; that is, let $dx = {\cdot}05$.

Then, for a so-called 8-inch gauge, the glass measure being supposed correctly made, the percentage error (E_8) will be

$$E_8 = \frac{2cx \times {\cdot}05 \times 100}{cx^2}.$$

$$E_8=\frac{2\times{\cdot}05\times100}{x}.$$

$$E_8=\frac{{\cdot}05\times100}{4}=1{\cdot}25.$$

For a so-called 2-inch gauge

$$E_2=\frac{{\cdot}05\times100}{1}=5.$$

For a so-called 5-inch gauge.

$$E_5=\frac{{\cdot}05\times100}{2{\cdot}5}=2.$$

Hence it appears that the results of 5-inch gauges should be more in accordance with those of 8-inch than with those of 2-inch gauges, which is practically found to be the case.

Theoretically and practically it is better to employ an 8-inch gauge than one of less magnitude. It is desirable that uniformity of construction should prevail, to obtain comparable results. Then, when such uniformity has become general, the influence of locality and relative exposure will be traceable, and it will be desirable that observers of the rainfall should explain the topography of their districts, and the positions of exposure of the rain-gauges, in their returns.

SUNDRY NOTES.

Hailstorm near Oxford, July 5, 1852.

Sheatley, Reading.

My dear Sir,—The paper in the last Number of the 'Meteorological Journal' is so interesting to me, that I have copied out an extract from my own journal, about which you can best judge if it would be interesting to others; and it seemed to me worth while to point out the observation of Humboldt in the Andes. I hope ere long to send you something for perusal about auroras, and some considerations of the great irregularity in observations of maximum solar heat, owing to the want of uniformity in the mode of exposure.

Yours sincerely,
John Slaten.

J. Glaisher, Esq.

Extract from the Meteorological Record kept by the Rev. J. SLATEN *at Rose Hill, near Oxford, in* 1852, *relative to Hailstorm on July* 5 *of that year.*

July 5, 3 P.M.—Thunderstorm with tremendous hail. Main force elsewhere; but such hail as never seen here. The first part of the storm had hailstones ¾ in. in diameter and ¼ in. thick, with nucleus and five or six concentric layers. These were like comfits poured out on a slab: many pieces of ice were picked up consisting of four or five of these nuclei joined together by a thin sheet of ice*. The sun broke out towards the close, and there was a most beautiful sight of glistening silver rain, when suddenly, at the close of all, the hail began again, of a tremendous size, just the same size and appearance as the nitre-balls sold by the chemists (*i. e.* 0·5 in. or 0·6 in. in diameter), and, mixed with these, large pieces of ice measuring 1¾ in. by 1¼ in., regular ellipsoids with a single nucleus, and very rough coating containing many bubbles of air: these broke glass wherever they fell; the others were comparatively light.

At Nuneham, where much damage was done, no hail fell till the end of the storm; and then solitary bits of ice, like gingerbread, with ragged and somewhat stellate forms, dropped at intervals; so it was reported to me.

After the storm had fully passed, a rushing, roaring sound was heard in the air far off, supposed to be caused by the hail falling.

The wind, in the morning a point E. of S., was S.S.W. at threatening of storm, went round the compass, and the storm fell upon us from S.E.; wind went round to N.W. and N., and fell off towards the E. at night.

---

* This is like the hail of the Andes. V. Humboldt, 'Views of Nature' (Bohn's translation, p. 392), says, "They [the deserts of the Andes] are stormy.... visited by terrific hailstorms, the hailstones being not only flattened by rotation, but also run together into thin floating plates of ice called ira paxara, which cut the hands and faces in their fall."

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OF

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Session 1865–66,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., at 7 p.m.

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1866.	January	17	„	April	18
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1866, JUNE 20.

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C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Rev. G. W. Brameld, M.A., East Markam, near Taxford, Notts;
Samuel Courtauld, Esq., Gosfield Hall, near Halstead, Essex;
Thomas Devas, Esq., Wimbledon, Surrey;
Rev. Edward John May, D.D., Standard Hill, Nottingham;
F. Pastorelli, Esq., 208 Piccadilly, W.C.;
Captain Thomas Waring, Waringstown, County Down, Ireland;
William Westgarth, Esq., jun., 5 Hadley Street, Kentish Town, N.W.;

were balloted for and duly elected Fellows of the Society.

The name of One Candidate for admission into the Society was read.

CXX. *On the Barometrical Pressure, Temperature, and Rainfall of Birmingham, from observations taken from* 1853 *to* 1864.

By D. Smith, Esq., F.R.A.S., F.M.S.

In aiming, in the following paper, to arrive at a correct mean of the meteorological elements of the borough of Birmingham for permanent reference, care has been taken to choose only such records as might be relied upon for the accuracy of the instruments employed and the proper precaution used in observing. As but very few reliable records have been kept here since the death of Dr. Ick in 1844, the choice has been necessarily limited. The materials for this paper have been derived, first, from observations taken by the late Mr. Thomas Southall at his residence in Wellington Road, Edgbaston, the accuracy of which will scarcely be questioned by any who were at all acquainted with him and his scientific pursuits. Mr. Southall's observations extend over six years for barometer (1855 to 1860 inclusive), over eight years for temperature, and five years for hygrometry. The barometer was of Barrow's construction, of 0·32 in. diameter, with mercury boiled, and an index-error, from Mr. Glaisher's examination, of 0·003; the cistern was fixed at an elevation of 455 feet above the mean sea-level; and in the following reductions these several adjustments and corrections have been applied. The dry, wet, maximum and minimum thermometers were by Casella and Co., and compared at Kew; their index-errors have also been applied. The thermometers were fixed in a well-shaded stand 4 feet 6 inches from the ground, and free from lateral walls, trees, or other vitiating objects. The rain-gauge was "Glaisher's," of 8 inches diameter, with receiving-surface 8 inches above the ground. The observations for the most part were taken twice a day, at 9 A.M. and 8 P.M.

Another contribution to these results was derived from observations taken simultaneously with the preceding by Mr. William Southall, of Calthorpe Street, Edgbaston, brother of the late Mr. Thomas Southall, extending from 1854 to 1864. A fair evidence of their value may be shown from the fact that a constant comparison was kept up between the two. This series has been used mainly in testing the accuracy of the former in cases of doubt, and in supplying omissions and occasional breaks, where admissible. The barometer is of local make, of large bore—nearly 1 inch in diameter, and is a superior instrument, so far as finish is concerned. But as some essential points have been omitted in its construction, and it has not undergone the usual comparison with the standard, the readings could not lay claim to strict accuracy. On a comparison of the readings of this instrument with those of Barrow's and a standard of Negretti and Zambra's, an equation was arrived at by which to reduce them to a standard value. The cistern of the barometer was 517 feet above the mean sea-level. The thermometers were placed in a shaded stand, as in the case of Mr. Thomas Southall's. The maximum and minimum thermometers not being compared, their readings could serve only, under due correction, for comparison and to supply deficiencies. The wet- and dry-bulb were by Negretti and Zambra, were compared by Mr. Glaisher, and have been adopted without reserve. Two observations were taken daily—at 9 A.M. and 9 P.M.

A third source whence these results have been derived has been observations taken by myself from 1856 to 1864. The barometer, although a good local one, and compared with a Kew standard, and its errors noted, was removed in 1862 to make way for a more trustworthy instrument, by Negretti and Zambra, of Mr. Glaisher's comparing. Some of the thermometers having the same objectional characters were removed at an earlier date, and Kew and Greenwich tested instruments alone admitted. This last series, taken at 63 Bloomsbury Street, at 340 feet above the mean sea-level, has been used from 1862 to 1864, that of Mr. W. Southall from 1860 to 1862, and that of Mr. T. Southall from 1853 to 1860, whilst the whole for the entire period have been carefully collated to ensure trustworthiness, so far as this limited period and means would allow.

Wind and Cloud.—As the rate and pressure of wind taken daily at one observation only, in the absence of instruments, can, at the best, be but approximate and frequently delusive, they are omitted in the following observations, as is also, and for the same reasons, the "amount of cloud."

Ozone.—Observations for ozone were taken for a few years, but, the results being so perplexing and unsatisfactory, were ultimately discontinued. The papers employed were Moffatt's and Schönbein's, both papers being suspended in an airy darkened box. The presence of ozone would be frequently given by one, and its absence at the same time shown by the other, and *vice versâ*; whilst at other times the two papers would give different amounts. The results, however, clearly indicated what has been long known of this element,—that when the wind is brought across the town to an outlying station, a great deficiency, and almost entire absence, is shown; and when the wind blows from the iron and colliery districts, the air is almost wholly deozonized. A source of vitiation was also occasionally annoying, arising from the influence of chemical manufactures. When a reliable test shall have been established, ozone-observations will be resumed.

TABLE I. Mean Monthly and Annual Barometric Pressure from 1855 to 1864 inclusive, adjusted to the sea-level and corrected for Temperature, &c.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly means.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1855.	30·100	29·740	29·640	30·050	29·840	30·130	29·935	30·027	30·215	29·691	30·075	29·923	29·947
1856.	29·619	30·059	30·226	29·784	29·838	30·052	30·002	29·935	29·834	30·160	30·102	29·796	29·950
1857.	29·824	30·107	29·901	29·820	30·006	30·069	30·038	30·065	29·977	29·898	30·163	30·284	30·012
1858.	30·339	30·034	29·978	29·986	29·960	30·139	29·995	30·037	30·046	30·026	29·965	29·936	30·036
1859.	30·186	29·985	30·025	29·810	30·032	29·989	30·137	29·995	29·869	29·722	29·978	29·775	29·958
1860.	29·635	30·060	29·848	30·017	29·951	29·786	30·055	29·718	29·959	30·028	29·930	29·709	29·891
1861.	30·163	30·025	29·789	30·201	30·130	29·965	29·740	30·004	29·851	30·016	29·697	30·147	29·977
1862.	29·866	30·081	29·666	29·984	29·873	29·850	29·876	30·024	30·022	29·839	29·965	29·975	29·920
1863.	29·705	30·264	29·862	29·963	30·025	29·854	30·121	29·862	29·799	29·760	29·985	30·055	29·937
1864.	30·167	29·923	29·646	30·062	30·016	29·903	30·123	30·088	29·898	29·855	29·769	30·022	29·956
Monthly means	29·959	30·027	29·858	29·967	29·967	29·973	30·002	29·975	29·947	29·899	29·962	29·962	29·958

TABLE II. Showing the highest, lowest, and extreme Yearly Range of Barometer, from Table I.

	Highest.	Lowest.	Range.
	in.	in.	in.
1855.	30·215	29·640	·575
1856.	30·226	29·619	·607
1857.	30·284	29·820	·464
1858.	30·339	29·936	·403
1859.	30·186	29·722	·464
1860.	30·060	29·635	·425
1861.	30·201	29·697	·504
1862.	30·081	29·666	·415
1863.	30·264	29·705	·459
1864.	30·167	29·646	·521

From Tables I. and II. it will be seen that—	inches.
The mean atmospheric pressure corrected and reduced to the sea-level was	29·958
The highest monthly pressure was that of January in 1858	30·339
The lowest monthly pressure was that of January in 1856	29·619
Giving a monthly range of	0·720
The highest yearly pressure was that of 1858	30·036
And the lowest that of 1860	29·891
Giving a yearly range of	0·145
The highest absolute reading from daily observation was on February 9, 1862	30·691
The lowest on January 24, 1860	28·648
Giving an extreme range of	2·043

TABLE III. Showing the Mean Monthly Temperature reduced from the Daily Readings and corrected for index-errors, and diurnal and monthly range, from 1853 to 1864.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1853.	38·9	30·1	35·1	43·0	48·7	55·7	57·5	56·9	53·3	48·3	40·3	33·6	45·1
1854.	36·1	39·5	43·1	47·8	48·8	54·5	57·6	57·4	56·1	46·8	39·6	40·5	47·3
1855.	35·4	27·8	37·1	44·4	46·9	53·6	59·8	58·3	55·4	48·3	40·3	35·3	45·2
1856.	37·6	41·0	38·5	45·4	47·0	55·9	58·8	60·4	53·3	49·2	40·7	39·1	48·9
1857.	36·0	37·8	40·2	44·0	50·4	60·1	60·8	62·0	57·8	51·5	44·2	44·8	51·1
1858.	37·6	34·5	40·6	44·9	50·6	61·9	57·9	59·6	57·8	48·9	38·9	40·1	47·7
1859.	40·1	41·5	45·0	44·4	50·9	57·6	63·9	60·9	55·0	48·6	40·5	34·0	48·5
1860.	38·1	35·4	40·8	42·2	52·1	53·0	56·4	55·3	52·0	49·4	40·1	34·0	45·7
1861.	37·8	40·5	41·3	44·3	52·5	57·0	58·5	59·3	55·6	53·7	41·3	39·0	48·4
1862.	38·9	40·8	41·1	48·1	54·1	54·7	57·1	58·2	55·0	50·8	37·5	42·7	48·2
1863.	40·2	41·5	42·7	47·7	51·1	55·9	59·3	59·7	52·5	49·6	44·8	43·5	49·0
1864.	34·5	35·5	40·1	46·7	51·6	56·1	59·9	57·8	55·6	49·1	41·6	37·8	47·2
Monthly Means	37·6	37·1	40·5	45·2	50·4	56·3	59·0	58·8	54·9	49·6	40·8	38·7	47·6

TABLE IV. Showing the greatest Heat attained by Maximum Thermometer in each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1853.	52·0	41·0	52·5	63·0	75·0	77·0	78·0	78·0	69·0	62·0	57·5	50·0	62·9
1854.	56·0	54·0	62·0	76·0	71·0	77·5	83·5	81·0	81·0	65·0	58·5	56·5	68·5
1855.	52·5	45·5	57·5	68·5	83·0	77·6	76·3	77·0	73·2	64·0	55·1	50·0	65·0
1856.	51·1	55·2	59·0	69·0	68·0	84·4	83·0	87·3	70·6	65·2	55·8	59·0	67·3
1857.	51·2	52·0	60·8	67·0	73·0	86·0	81·0	84·0	79·0	69·8	58·3	56·0	66·1
1858.	52·0	51·6	65·8	75·0	83·8	87·0	81·6	84·0	81·5	66·6	55·2	54·6	69·8
1859.	54·0	55·0	62·5	77·3	74·0	78·0	89·2	83·4	73·2	76·8	56·0	53·0	69·0
1860.	54·5	50·0	59·8	65·0	75·5	71·0	74·0	68·6	69·5	67·5	51·9	52·3	63·3
1861.	54·0	55·5	59·0	71·0	80·5	84·0	78·0	79·0	79·2	71·5	60·2	54·2	68·6
1862.	55·2	54·7	58·0	72·3	77·8	72·7	73·5	76·3	69·3	67·0	61·7	53·7	67·1
1863.	52·8	53·0	61·4	63·9	73·9	73·0	84·0	75·7	63·5	64·0	59·8	54·9	64·9
1864.	53·5	58·0	62·5	73·0	86·5	74·2	83·2	83·8	72·0	64·0	55·0	53·2	66·5
Monthly Means	53·2	52·1	60·0	70·0	76·8	78·5	80·4	79·8	73·4	66·9	57·3	49·4	66·5

TABLE V. Showing the greatest Cold attained by Minimum Thermometer in each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1853.	27·0	16·5	17·0	29·0	26·0	37·0	44·0	42·0	35·5	29·0	23·5	8·0	27·8
1854.	5·0	25·0	22·0	27·5	33·0	36·5	43·0	40·0	37·5	27·0	19·0	24·0	28·2
1855.	19·5	3·5	24·0	23·0	28·0	37·5	44·0	41·5	30·0	29·0	25·5	13·0	26·5
1856.	19·8	23·0	22·0	29·0	30·0	39·0	41·5	42·0	39·5	28·0	24·0	16·0	29·4
1857.	16·5	14·0	27·0	28·0	32·5	40·0	45·0	46·0	38·0	36·0	26·0	31·0	31·6
1858.	22·0	22·0	14·2	24·2	31·9	41·9	38·6	40·0	41·8	32·2	19·0	30·0	29·8
1859.	27·6	28·5	27·2	23·5	33·0	41·0	47·8	42·0	37·5	22·1	21·4	6·1	29·8
1860.	23·0	23·0	20·0	27·0	31·9	39·8	46·0	44·0	33·6	31·8	31·0	−2·5	29·4
1861.	17·2	17·3	30·8	28·0	30·3	42·8	47·2	46·8	35·0	33·4	22·0	22·8	31·1
1862.	34·1	21·8	23·4	26·0	35·4	40·7	41·4	42·6	38·5	31·5	19·0	29·2	31·9
1863.	23·6	24·0	24·9	31·7	28·2	41·3	38·1	46·8	39·8	30·3	31·3	28·0	32·3
1864.	9·6	15·4	25·7	31·0	34·6	34·4	45·3	33·6	40·2	35·9	27·8	16·9	29·1
Monthly Means	20·4	19·2	23·1	27·3	31·1	39·3	43·4	42·2	37·2	30·5	24·1	18·5	29·7

Table VI. Showing the extreme Range of Temperature taken from the highest Maximum and the lowest Minimum of each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1853.	25·0	24·5	35·5	34·0	49·0	40·0	34·0	36·0	33·5	33·0	34·0	42·0	35·0
1854.	51·0	29·0	40·0	48·5	38·0	41·0	40·5	41·0	44·5	38·0	39·5	32·5	40·2
1855.	33·0	42·0	33·5	45·5	55·0	40·1	32·3	35·5	43·2	35·0	29·6	37·0	37·6
1856.	31·3	32·2	37·0	40·0	38·0	45·4	41·5	45·3	31·1	37·2	31·8	43·0	37·8
1857.	34·7	38·0	33·8	39·0	40·5	46·0	36·0	38·0	41·0	33·8	32·3	25·0	36·0
1858.	30·0	29·6	51·6	50·8	51·9	45·1	43·0	44·0	39·7	34·4	36·2	24·6	40·0
1859.	26·4	26·5	35·3	53·8	41·0	37·0	41·4	41·4	35·7	54·7	34·6	46·9	39·7
1860.	31·5	27·0	39·8	38·0	43·6	31·2	28·0	24·6	35·9	35·7	20·9	49·8	33·8
1861.	37·0	39·7	28·2	30·7	36·9	41·2	30·6	32·2	44·2	38·1	38·2	31·4	34·8
1862.	34·7	32·9	34·6	46·3	43·4	32·0	32·1	33·9	30·8	35·5	42·7	24·5	35·2
1863.	29·2	29·0	36·5	32·2	45·7	31·7	45·9	28·9	23·7	33·7	28·5	26·9	32·6
1864.	43·9	42·6	36·8	42·0	51·9	39·8	37·9	50·2	31·8	28·1	27·2	36·3	39·0
Monthly Means	33·9	32·0	36·9	41·7	44·5	39·1	36·9	37·6	34·6	36·3	32·9	34·9	36·8

Table VII. Showing the Mean Daily Range of Temperature taken from the mean of all the Maxima, and the mean of all the Minima of each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1853.	9·6	8·9	15·1	13·8	22·3	18·4	17·0	18·7	19·4	13·2	12·3	9·0	14·8
1854.	9·4	12·6	18·1	25·2	22·2	18·8	18·5	19·5	23·3	16·5	11·8	1·5	17·2
1855.	8·3	11·5	14·6	20·6	20·2	18·6	17·6	18·5	19·2	15·1	9·4	10·9	15·3
1856.	9·1	9·4	12·2	16·2	15·0	19·4	20·0	18·3	16·1	12·5	9·2	9·9	13·6
1857.	9·1	12·8	11·7	26·2	18·1	21·8	19·2	18·2	15·2	12·2	9·3	9·5	15·2
1858.	10·8	11·3	15·8	17·9	19·3	22·9	20·9	18·7	15·2	12·6	10·7	8·1	15·3
1859.	9·6	12·4	12·5	15·5	20·9	19·0	22·2	19·7	16·7	13·6	11·3	10·8	15·3
1860.	9·4	11·5	12·4	16·5	19·5	15·3	17·6	13·8	16·1	12·3	7·5	9·3	13·4
1861.	9·1	8·1	10·7	14·7	16·7	14·8	15·1	16·8	14·0	11·8	13·5	11·7	13·0
1862.	8·8	11·7	15·2	15·9	18·8	16·0	21·6	14·4	11·6	11·8	11·5	7·9	13·7
1863.	8·8	11·7	15·2	15·9	18·8	16·0	21·6	14·4	11·6	13·2	10·7	9·7	13·9
1864.	13·8	11·2	14·8	16·3	12·3	18·8	23·4	23·4	16·8	13·5	12·1	8·0	15·3
Monthly Means	5·4	11·1	14·0	18·8	18·6	18·3	19·5	17·8	16·2	13·1	10·7	8·8	14·6

Tables III., IV., V., VI., and VII. show that the mean temperature of the period, deduced from maximum, minimum, and dry-bulb readings, was	° 47·6
The highest mean monthly temperature was July 1859...	63·9
The lowest mean monthly temperature was Feb. 1855...	27·8
Giving a monthly range of	36·1
The highest temperature occurred July 12, 1859.........	89·2
The lowest temperature occurred Dec. 25, 1860	—. 2·5
Giving an extreme range of..................................	91·7

TABLE VIII. Showing the Mean Temperature of Dew-point in each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1856.	34·6	37·7	32·2	38·5	42·8	49·6	57·1	54·8	48·1	46·9	35·4	35·6	42·7
1857.	32·9	34·6	35·4	38·5	43·9	50·8	55·6	57·5	54·2	50·0	43·4	39·6	44·7
1858.	33·5	30·6	35·4	39·6	43·0	54·4	50·6	51·7	52·3	44·8	35·6	36·7	42·3
1859.	36·9	37·7	38·5	38·4	43·9	52·3	56·5	55·6	49·1	45·9	36·7	31·5	43·5
1860.	33·5	30·1	35·4	36·4	47·	49·1	50·4	50·2	48·0	44·8	34·4	31·2	40·8
1861.	34·6	37·7	38·1	38·8	43·3	52·9	51·8	56·4	49·8	49·2	38·1	36·1	43·9
1862.	37·4	39·3	38·3	41·2	46·5	46·7	49·3	51·2	50·3	45·4	35·3	39·2	43·3
1863.	36·4	37·1	36·5	41·0	43·7	49·5	49·8	54·7	46·6	45·6	42·2	39·2	43·5
1864.	31·8	32·8	33·4	38·0	43·9	48·2	50·4	47·4	49·0	44·9	38·7	36·2	41·2
Monthly Means	33·5	35·2	35·9	37·8	44·2	50·3	52·3	53·1	49·7	46·3	37·7	36·1	42·8

TABLE IX. Showing the Mean Degree of Humidity in each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
1856.	91	92	83	78	73	76	82	77	80	93	84	91	83·3
1857.	94	91	84	78	74	72	77	82	87	93	92	86	84·1
1858.	91	91	84	79	69	68	71	72	81	86	91	92	81·2
1859.	92	92	82	78	76	81	70	77	87	93	92	93	83·5
1860.	91	85	84	78	80	81	76	81	90	86	88	93	83·5
1861.	93	88	85	77	69	76	82	77	81	86	91	93	83·1
1862.	93	94	90	76	76	73	72	76	82	83	93	85	82·7
1863.	92	88	84	82	74	75	72	82	74	93	86	87	82·4
1864.	93	96	83	73	74	73	76	70	80	91	92	94	82·9
Monthly Means	92·2	90·7	84·3	77·6	73·8	75	75·3	77·1	82·4	87	88·7	90·4	82·7

TABLE X. Showing the amount of Rain deposited in each Month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Totals.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1853.	2·21	0·90	1·41	1·71	1·52	4·47	4·08	2·72	2·33	4·04	2·01	1·22	28·62
1854.	3·51	1·08	0·64	0·42	1·71	1·62	4·03	2·20	0·91	1·32	1·82	1·95	21·21
1855.	0·47	1·77	1·90	0·81	1·52	2·74	5·13	1·58	0·72	5·03	0·94	1·06	24·67
1856.	3·16	2·13	1·31	2·60	3·11	2·47	1·71	5·76	3·37	3·36	1·37	2·61	32·96
1857.	3·11	1·49	2·21	2·60	1·28	3·22	2·10	3·44	3·46	2·48	1·53	0·75	26·67
1858.	0·89	1·07	1·32	4·02	2·33	3·79	2·89	2·82	2·63	3·07	0·76	2·13	27·72
1859.	1·58	2·02	2·21	2·47	1·35	3·09	1·95	3·48	2·90	3·03	3·05	2·63	29·76
1860.	3·78	0·81	2·01	1·08	2·40	6·26	1·45	6·39	2·44	1·93	2·86	3·75	35·16
1861.	1·07	2·68	3·21	1·07	0·85	4·80	5·86	0·84	3·28	1·88	2·70	1·51	29·75
1862.	3·19	0·66	4·44	2·18	3·76	2·23	2·11	1·71	5·0	3·11	0·87	2·05	31·31
1863.	3·115	0·585	0·914	0·956	0·524	4·213	0·905	3·38	2·331	3·953	2·353	1·275	24·504
1864.	1·147	1·767	3·44	1·45	1·591	1·635	0·88	0·478	3·457	2·565	2·415	2·68	23·505
Monthly Means	2·269	1·414	2·084	1·786	1·828	3·378	2·762	2·900	2·735	2·981	1·89	1·967	27·986

TABLE XI. Showing the number of Days in each Month in which Rain fell.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Totals.
1853.	17	16	17	16	9	18	20	11	12	24	8	15	183
1854.	20	11	10	6	18	10	17	12	9	14	15	21	163
1855.	10	13	15	9	13	12	18	12	4	17	11	14	148
1856.	20	14	5	15	18	10	11	16	16	10	12	18	165
1857.	20	12	16	15	11	13	10	10	14	15	14	10	160
1858.	13	10	17	11	17	9	13	18	16	16	10	22	172
1859.	18	17	13	15	9	14	10	16	18	13	15	18	176
1860.	23	12	23	16	15	28	9	26	16	17	19	17	221
1861.	6	19	23	11	5	18	26	13	20	16	15	11	183
1862.	20	10	23	18	21	18	18	15	13	20	14	21	211
1863.	21	13	9	15	9	16	7	20	22	21	15	13	181
1864.	16	13	16	9	10	16	7	8	19	14	19	12	159
Monthly Means	17	13·3	15·5	13	12·9	15·1	13·6	14·7	14·9	16·4	13·9	16	176·8

Tables X. and XI. give the mean yearly rainfall as deduced from the twelve years	27·99 in.
And the mean number of days on which rain fell	176·8 days.
The greatest monthly deposit was in August 1860	6·39 in.
And the least monthly deposit was in April 1854	0·42 in.
The greatest yearly deposit, was that of 1860	35·16 in.
And the least that of 1854	21·21 in.
The greatest number of days upon which rain fell in any year was in 1860	221 days.
The least number in 1855	148 days.
The month of May has had the fewest days of rain	12·9 days.
And the month of January the most	17 days.
The greatest number of days in any single month upon which rain fell, was in June 1860	28 days.
And the least number in September 1855	4 days.

CXXI. *Results of Meteorological Observations taken at Mentone (Western Bay), South of France, during the Winters of* 1863–64, 1864–65, *and* 1865–66. By D. A. Freeman, Esq., F.M.S.

In the following paper I propose to lay before the Society the results of the meteorological observations which I have made at Mentone (Western Bay), in the South of France, during the last three years. Mentone being now an established place of refuge and resort during the winter and spring for many hundreds of invalids, principally English, I trust that the observations of a disinterested witness, and their comparison with those made by M. de Bréa, a resident there for many years, may be acceptable to the Society and of some value to the public.

My observations have extended over the periods between the 1st of October and the 15th of May, 1863–64, 1864–65, and 1865–66.

During the first winter and spring, the thermometers were suspended from woodwork placed against the northern wall of my house; but during the two succeeding winters they were placed at some distance from the house, in a well-ventilated box of the construction described at p. 122 of the 'Journal of the Scottish Meteorological Society' (New Series). The height of the instruments above the sea-level was about 80 feet.

From the 1st of November 1863 to the 1st of February 1864, the mean temperature is derived from the daily maximum and minimum, and from observations at 8 A.M. and at 2 P.M. From the 1st of February to the 15th of May 1864, and during the two succeeding winters, the mean temperature is derived from the daily maximum and minimum, and from the observations of the dry-bulb thermometer, taken daily, at 9 A.M. and at 9 P.M.

The barometrical observations were taken during the first winter with an aneroid, and during the two following winters with a good mercurial barometer.

Neither the position of the instruments, nor their character, during the first winter, enable me to place quite so full a reliance on the observations of that winter as on those taken during the two following winters. During those winters, the thermometers used were all graduated on the stem, and had been tested at Kew, and their position and exposure were satisfactory.

Beyond the expression of an opinion which I may venture to make, that the climate is peculiarly agreeable, in consequence of the generally dry, fresh, and bracing character of the air, of the large amount of sunshine, and of the entire absence of fog, I shall confine myself to a record of observations, and to a statement of a few facts connected with them.

As I have not remained at Mentone during the summer months, I am unable to deduce the mean annual temperature from daily observations throughout the year; but I have deduced it for the years 1864 and 1865 in the mode suggested by Sir J. Herschel in his work on 'Meteorology,' viz. by taking the mean of the mean daily temperature between the 17th–30th of April and the 14th–27th of October in each year. This gives for 1864, as the mean temperature, 60°·8, and for 1865, 62°·1. The mean annual temperature deduced by M. de Bréa from a series of observations extending over a period of ten years (1851–60), taken at 6 A.M. and at 2 and 10 P.M., is 61°.

The following Table compares the mean temperature as deduced by M. de Bréa, from the same series of ten years observations, for the months of October to April, with the mean temperature deduced from my observations:—

	M. de Bréa's mean of ten years.		The writer's mean of three years.
January	48°·7	....	49°·2
February	49·1	....	50·3
March	52·9	....	51·5
April	58·3	....	58·6
October	64·2	....	62·2 (two years).
November	53·8	....	57·2
December	49·1	....	51·7
Mean of seven months	53·7	....	54·4

Snow.—In February 1864 a fall of snow following a heavy hail-storm, lay on the ground, at the sea-level, for four or five days in sheltered places; and in March 1865 there were some heavy showers of mingled snow and hail, but it melted as soon as it fell. No snow fell at the sea-level during the winter of 1865–66.

Wind.—During the winter of 1864–65, gales of wind were frequent. The hardest were from the S.E. (sirocco) on the 6th of December, and from the N.W. (mistral) on the 14th of January, 20th of February, and 26th of March.

Gales were not so frequent during the winter of 1865–66. The hardest were on the 11th of January and 13th of February, both N.W.; on the 12th of May from the W., and on the 13th of May from the N.

I have observed that copious dews have been generally followed by high winds.

Thunder and Lightning.—During the winter of 1864–65, there was thunder with lightning on the 24th of October, and lightning on the 21st and 26th of that month and on the 3rd and 24th of November. There was thunder with lightning on the 18th of December, lightning on the 17th and 22nd of January, and thunder and lightning on the 24th of March.

During the winter of 1865–66 there were thunder and lightning on the 8th, 13th, 18th, and 23rd of October, and lightning on the 12th, 14th, 15th, and 20th of that month. There were thunder and lightning on the 6th of November, and on the 1st and 2nd of of December, and lightning on the 3rd of December, and on the 3rd, 9th, and 10th of March. There were thunder and lightning on the 19th and 23rd of March, and on the 2nd, 8th, 9th, 21st, and 22nd of April, and lightning on the 1st, 3rd, and 8th of that month. There were thunder and lightning on the 2nd of May, and lightning on the 12th and 15th.

Rain.—Rain fell on fifty-seven days between the 1st of October

1863 and 15th of May 1864, on eighty days between the 1st of October 1864 and 15th of May 1865, and on seventy-eight days between the 1st of October 1865 and 15th of May 1866.

The following Table shows the amount of rainfall in each phase of the moon between the 1st of October and 1st of May 1864–65 and 1865–66:—

	New moon to first quarter.	First quarter to full.	Full to last quarter.	Last quarter to new.		New to full.	Full to new.
	in.	in.	in.	in.		in.	in.
1864–65.	1·89	3·38	17·94	12·09	Total	5·27	30·03
1865–66.	6·80	7·72	11·41	7·20	Total	14·52	18·61

According to the observations of M. de Bréa, during ten years the mean annual number of sunshiny days, without clouds, was 214, of days of sunshine and clouds 45·7, of overcast days 24·8, and of days on which rain fell, little or much, 80·8; and the smallest number of days on which rain fell in any one of the ten years was 65 (in 1854), and the largest number was 105 (in 1855).

There are some sheltered spots about Mentone which the swallows do not quit during the winter; but the swallows of passage I first observed in the winter of 1863–64 on the 4th of March, and in that of 1865–66 on the 3rd of March.

I observed the first fireflies in the spring of 1865 on the 6th of May, and in that of 1866 on the 4th of May.

Temperature.—It will be observed, in the Table of ten-day means, that the coldest decade, during the three winters, was the third decade of March 1865, when the mean temperature for that period was 43°·5. The next coldest decade was the first decade of February 1864, with a mean temperature of 44°·6. The next coldest were the second and first decades of January 1864, with a mean temperature, respectively, of 44°·8 and 45°·4. The only other decades, during the three winters, when the mean temperature was below 50° were the third decade of January and the third decade of December 1864, the second decade of January, the second and third decades of February, the second decade of March, and the second decade of December 1865.

The mean temperature a little exceeds 60° in the month of October, and it occasionally a little exceeds 60° in April and May, after the first decade in April; but it will be seen that during the months of November to March the mean temperature ranges generally between 50° and 60°.

Monthly Results of Meteorological Observations at Mentone, during the Winters of 1863–64, 1864–65, and 1865–66.

Year.	Barometer.			Self-Registering Thermometers.									Hygrometer.				Rain.		Ozone, Schönbein.	State of the sky.		
	Month.	Mean at 32°, and sea-level.	Monthly range.	Max. in month.	Min. in month.	Monthly range.	Mean of all maxima.	Mean of all minima.	Mean daily range.	Mean temperature.	Terrestrial radiation during night. Min.	Terrestrial radiation during night. Mean.	Dry-bulb at 9 A.M. and 9 P.M.	Wet-bulb at 9 A.M. and 9 P.M.	Dew-point.	Humidity (sat. = 100).	Number of days.	Amount in inches.	(Scale 1–10).	Brilliant sunshine.	Sunshine and clouds.	Covered.
		in.	in.	°	°	°	°	°	°	°	°	°	°	°	°			in.		days.	days.	days.
1863.	October	29·98	0·53	...	...	...	...	...	...	...	......	......	...	...	...	...	12					
1864.	„	29·72	0·72	73·0	51·0	22·0	67·3	55·9	11·4	61·3	48·0	52·3	61·2	56·5	52·7	74	12	13·52		9	16	6
1865.	„	29·81	0·70	79·8	54·0	25·8	68·0	58·0	10·0	63·1	50·5	55·7	63·1	57·9	53·5	71	12	9·19	7·0	16	8	7
Means ...	....	29·84	0·65	...	...	...	...	...	10·7	62·2	......	......	62·1	...	...	72						
1863.	November ...	30·00	0·94	70·0	46·0	24·0	63·2	52·7	10·5	58·5	39·0	47·0	...	...	...	...	7	1·56	6·3	17	7	6
1864.	„ ...	29·71	0·83	66·5	45·5	21·0	61·7	51·3	10·4	56·0	40·5	47·1	55·5	51·2	47·	73	19	4·16	8·0	12	15	3
1865.	„ ...	30·01	0·89	66·6	47·0	19·6	60·7	52·0	8·7	56·4	44·0	49·7	56·5	52·9	49·7	78	14	4·52	7·7	13	7	10
Means ...	....	29·91	0·89	...	...	...	...	...	9·9	57·2	......	......	56·0	...	...	75						
1863.	December ...	30·03	0·78	64·0	43·0	21·0	54·9	47·4	7·5	53·3	35·0	40·6	...	...	...	...	4	0·79	6·0	6	21	4
1864.	„ ...	29·91	0·82	63·5	40·5	23·0	56·2	46·4	9·8	50·8	36·0	42·7	50·1	46·4	42·5	76	12	7·93	8·3	13	8	10
1865.	„ ...	30·24	0·85	60·8	37·5	23·3	56·7	46·4	10·3	51·1	35·0	43·2	51·3	46·4	41·5	69	7	4·24	6·7	22	5	4
Means ...	....	30·06	0·82	...	...	...	...	...	9·2	51·7	......	......	50·7	...	...	72						

1864.	January ……	30·17	0·91	57·0	33·0	24·0	51·6	40·6	11·0	46·0	26·5	34·7	45·7	40·8	35·3	67	2	0·03	6·0	19	10	2
1865.	„ ……	29·73	1·03	63·5	38·0	25·5	56·2	45·6	10·6	50·2	34·5	42·1	49·5	45·8	41·9	75	9	1·93	8·3	18	7	6
1866.	„ ……	30·18	1·19	60·2	44·2	16·0	56·4	46·6	9·8	51·4	41·0	43·9	51·2	47·3	43·2	75	6	1·73	8·1	12	15	4
Means …	………………	30·03	1·04	…	…	…	…	…	10·5	49·2	……	……	48·8	…	…	72						
1864.	February ……	29·86	1·04	62·5	31·5	31·0	54·2	42·7	11·5	48·3	24·5	37·2	47·8	43·5	38·8	70	12	3·26	6·1	9	12	8
1865.	„ ……	29·77	0·94	64·5	36·0	28·5	55·2	42·5	12·7	48·4	32·0	38·4	48·0	43·0	37·5	67	7	2·33	…	15	9	4
1866.	„ ……	29·96	0·79	71·6	44·2	27·4	59·0	49·0	10·0	54·1	40·0	46·3	54·2	49·8	45·5	72	7	0·88	8·2	12	11	5
Means …	………………	29·86	0·92	…	…	…	…	…	11·4	50·3	……	……	50·0	…	…	70						
1864.	March ………	29·75	1·35	65·0	43·0	22·0	60·2	48·7	11·5	54·2	37·5	43·7	53·8	49·9	46·1	75	11	2·31	8·6	9	14	8
1865.	„ ………	29·65	0·86	62·5	34·0	28·5	54·5	41·7	12·8	47·9	31·0	38·0	47·2	43·6	39·6	76	13	5·04	…	11	12	8
1866.	„ ………	29·74	0·90	65·8	41·7	24·1	57·6	46·5	11·1	52·4	38·5	43·9	52·8	48·6	45·9	72	14	8·20	…	14	8	9
Means …	………………	29·71	1·04	…	…	…	…	…	11·8	51·5	……	……	51·3	…	…	74						
1864.	April ………	29·92	0·48	71·5	42·5	29·0	66·1	51·8	14·3	58·7	36·0	47·6	58·6	52·8	57·6	68	5	0·09	8·3	19	10	1
1865.	„ ………	30·11	0·61	72·5	41·0	31·5	66·2	53·9	12·3	59·9	35·5	47·5	59·7	55·6	52·0	76	6	0·42	…	19	6	5
1866.	„ ………	30·01	0·71	68·0	44·5	23·5	61·9	51·1	10·8	57·1	41·0	49·5	57·6	53·9	50·8	78	12	4·11	…	7	16	7
Means …	………………	30·01	0·60	…	…	…	…	…	12·5	58·6	……	……	58·6	…	…	74						
1864.	May 1–15 …	29·87	0·52	75·0	54·0	21·0	68·7	56·7	12·0	62·9	49·5	54·0	63·0	58·7	55·0	75	4	1·14	…	5	10	0
1865.	„ ……	30·05	0·44	75·5	56·5	19·0	71·0	58·7	12·3	63·8	51·5	54·5	65·0	60·5	56·8	75	2	0·29	…	9	6	0
1866.	„ ……	29·91	0·80	73·0	53·0	20·0	67·7	56·1	11·1	62·7	50·0	52·7	62·4	57·5	52·8	72	6	0·80	…	6	8	1
Means …	………………	29·94	0·59	…	…	…	…	…	11·8	63·1	……	……	63·5	…	…	74						
General Means }	………………	29·92	…	…	…	…	…	…	11·0	55·5	……	……	55·1	…	…	73						

Ten-day Means of the Temperature and relative Humidity at Mentone during the Winters of 1863–64, 1864–65, and 1865–66.

	October.						November.						December.							January.					
	First decade.		Second decade.		Third decade.		First decade.		Second decade.		Third decade.		First decade.		Second decade.		Third decade.			First decade.		Second decade.		Third decade.	
	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.		Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.	Mean Temperature.	Relative Humidity.
1863.	°……	……	°……	……	°……	……	61·4°	……	57·3°	……	56·7°	……	53·1°	……	54·2°	……	52·7°	……	1864.	45·4°	……	44·8°	……	48·9°	……
1864.	62·5	62	61·5	73	59·8	85	58·5	76	55·4	75	54·2	68	52·2	67	50·7	86	49·5	73	1865.	50·2	72	48·5	71	52·0	78
1865.	65·3	63	62·1	77	61·8	74	56·3	83	55·5	71	57·5	81	54·7	74	48·6	61	50·9	73	1866.	50·0	76	51·7	75	52·5	72
	February.						March.						April.							May.					
1864.	44·6	60	48·0	66	52·2	82	54·5	83	54·8	67	53·2	79	55·2	69	59·4	73	61·5	60	……	63·2	72				
1865.	51·3	63	46·2	69	47·7	71	50·4	69	49·7	74	43·5	81	56·5	70	61·4	78	61·9	80	……	64·9	76				
1866.	53·7	77	54·8	67	53·7	76	51·5	74	50·9	75	54·8	71	53·7	78	58·6	76	59·1	78	……	61·9	77	61·0			

Table of Temperatures in the Winter of 1865–66 shown by Blackened-bulb Thermometer in the sun's rays, and by Minimum Thermometers *exposed* at night.

Months.	Blackened-bulb Thermometer placed on white cotton-wool on the ground in the sun's rays.		Minimum Thermometer exposed at night on white cotton-wool on the ground.		Minimum Thermometer on the ground (sandy soil).		Minimum Thermometer exposed at 1 inch above the ground.		Minimum Thermometer exposed at 6 inches above the gound	
	Mean.	Maximum.	Mean.	Minimum.	Mean.	Minimum.	Mean.	Minimum.	Mean.	Minimum.
1865. October	° 106·6	° 138·5	° 49·4	° 41·5	° 52·5	° 45·5	°	°	° 55·7	° 50·5
November	83·8	99·5	44·7	35·0	47·2	38·0	48·8	42·5	49·7	44·0
December	78·3	87·0	35·7	24·0	39·0	30·5	41·7	33·0	43·2	35·0
1866. January	81·8	98·5	37·1	30·5	40·4	36·0	42·6	39·0	43·9	41·0
February	91·4	111·5	40·6	29·5	44·0	36·5	45·4	38·5	46·3	40·0
March	102·0	116·0	38·2	28·0	42·0	35·5	42·7	37·5	43·9	38·5
April	......	......	45·7	34·0	48·7	33·5	48·8	38·5	49·5	41·0
May (twenty-one days).	......	......	47·9	40·5	......	......	51·2	44·5	52·1	48·0
Mean of Means during the eight months	......	......	42·4	......	......	......	......	......	48·0	
Absolute Minimum ...	......	......	......	24·0	......	30·5	......	33·0	......	35·0

CXXII. *On the best means of measuring Terrestrial Radiation.*

By Fenwick W. Stow, Esq., M.A., F.M.S.

The widely differing results of observations of terrestrial radiation leads one to ask, "Is there so very great a difference in climate and soil, in thickness or clearness of the atmosphere, in places in the same island or even the same county as to account for this divergence?" Before this question can be answered, we must see whether the modes of ascertaining the amount of radiation are such as to give comparable results. I venture to think they are not.

It is indeed quite possible that in certain damp situations, as the valleys of rivers, the amount of radiation may be considerably diminished by the prevalence of mist near the surface of the ground at night, the temperature of the air being lowered in consequence, as the radiation then takes place principally from the upper surface of the mist, often only a few feet from the ground; but I do not see how we can have any trustworthy data to determine the extent to which this may prevail, without good comparative observations at different places. Not that I would undervalue the importance of long-continued and careful observations at the same place; but it is evident that so long as they stand alone they can furnish but little knowledge of the general nature of our climate, however valuable they may be in themselves, or whatever the care and pains bestowed on them by the individual observer.

At present we constantly hear and see the readings of the "thermometer on grass" quoted without a word of explanation whether long or short grass is meant, whether the thermometer was placed on a piece a foot square close to a house, or in the middle of a field, and, lastly, whether the instrument was one of great sensitiveness or the ordinary alcohol minimum with round bulb, which is by no means, as I shall show, an unimportant question.

I shall first show that, so long ago as 1844, Mr. Glaisher pronounced decidedly against the material now almost universally used for placing the thermometers on. In the report on his extensive and almost exhaustive experiments made in that year, he says:—

"The readings of thermometers placed on grass being found so variable, the unfitness of it to furnish the means of comparing the degrees of cold at night on the surface of the earth was evident. A much greater uniformity was observed in the results of experiments made with other substances, which were bad conductors of heat, and whose condition was always the same."

And again, "The readings of thermometers placed on grass were found to differ with every variation of length, fineness, and closeness of its blades."

I believe that most of those who have made this subject their study have come to the same conclusion. For example, Dr. Wells, who was, I believe, one of the first to state the true theory of the formation of dew, expresses the same idea in words almost identical with those which I have quoted from Mr. Glaisher.

It is true that the average difference between long and short grass was found to be only 1°·1; but on clear nights, when the temperature falls low, the heat from the earth beneath is so readily conducted through short grass as to cause this difference to be equal on some rare occasions to the whole difference between the temperature of long grass and that of the air at 4 feet. This would probably only occur with very low temperatures in winter; but even at the end of last month, when a minimum temperature of 31° was registered at 4 feet, I observed that the temperature registered on a plot consisting only of very short grass was only 7° lower, when that on long grass was 14° lower than the temperature of the air.

Others will be more competent than I to say what substance would be most suitable for the purpose; and I gather from the general tenor of Mr. Glaisher's remarks in the paper I have alluded to, that wool is the substance he prefers: I only raise my voice against persisting in the use of a substance which, although so readily accessible, is declared by competent authority to be useless for the scientific investigation of this subject. I now pass on to the question of instruments.

Some little time ago Mr. Symons suggested to me that it would be useful to compare the readings of the mercurial minimum with those of the ordinary radiation-thermometer, and at the same time to try the black-bulb thermometer recommended by the Scotch Meteorological Society. I therefore procured two mercurial minimums (one of them having a black bulb), and two of the ordinary standard radiation-thermometers with uncoloured spirit, another with red spirit, and another with a black bulb. I also applied to Mr. Casella for the most sensitive spirit minimum he possessed, and was fortunate in obtaining one with a much elongated and bent bulb, one of two which had been made for a special purpose, and with great care, and of a form, as I understood from him, which he had not previously tried. I found this thermometer more sensitive than the black-bulb mercurial, and about equal to the other, which had a very small bulb; and this result of a few rough experiments was confirmed by the radiation-observations I afterwards made. Of the spirit minimums of the ordinary pattern, the red spirit had the smallest bulb—the others being nearly equal in this respect, and having bulbs of the ordinary size, the black bulb being, if anything, the largest.

I then compared these instruments with a standard, by placing them horizontally in a bath with water, which was allowed gradually to cool, and then artificially cooled down and allowed to rise, by which means I obtained the corrections for the index of each instrument within the temperatures of 35° and 70° by about 100 observations. This error in no case exceeded 0°·4, and was so uniform that I think the corrections I have applied may, even for much lower temperatures, be relied on as accurate.

These instruments I placed on wool, near the lower part of a sloping piece of long grass, about half an acre in extent, in our garden at Ripon. The wool used was some that happened to be at hand, which had been used for packing, and looked like the scrapings of blankets. Of this I made a level surface about 18 inches square, and placed the thermometers with the bulbs in the centre. I commenced my observations each evening about half-past 7^h^, and continued them at intervals of twenty minutes or half an hour till 9^h^ or shortly after, which was as late as I could see clearly to read them. I generally looked at them again about 10^h^, and then not again till the next morning. I could not possibly have had more favourable weather for the purpose, the sky being generally cloudless for the first ten days, and the air very dry, so that there was very little dew deposited. In such weather the amount of radiation, as might be expected, was very great—the difference between the wool and the air at 4 feet reaching 23°·7 on one occasion; and the sensitiveness of the thermometers was well tested.

A mean of thirty observations taken under these circumstances, between the 16th and 22nd of May, gave the following results:—

Mean temperature registered at 4 feet	45°·9
Mean excess of that above the lowest radiation-thermometer	17·3
Mean excess of the readings of each instrument above the lowest thermometer on each occasion, as follows:—	
Mercurial minimum	0°·3
Sensitive spirit minimum	0·4
Mercurial minimum with black bulb (only seventeen observations)	1·3

	°
Ordinary standard, minimum, No. 1	1·9
„ „ No. 2	1·9
Minimum with red spirit	2·2
Minimum with black bulb	2·5

From this it appears that the ordinary pattern of minimum thermometers registered temperatures on an average more than 1½° higher than those that were most sensitive, and that those which were most absorptive of radiated heat by day, were ½° higher still.

On cloudy nights, when the sky was on an average covered with clouds over three-fourths of its extent, the clouds being, however, generally high, these differences were diminished by one-third, but almost exactly the same proportions maintained. This result was deduced from nineteen observations. These results considerably astonished me, and I therefore determined to try if the same would be the case on grass. I therefore placed five of the instruments on long grass, bending down the blades and taking great care that, if possible, the bulbs should be similarly situated. The amount of radiation continuing nearly the same, as shown by the two instruments left on the wool, an average difference of 12° took place between the air and the grass, and still the ordinary minimum was left far behind, less only by 0°·1 than it had been on the wool; but the red-spirit and black-bulb were only 0°·2 higher still, instead of 0°·3 and 0°·6 respectively.

To determine whether the difference between the uncoloured and coloured bulbs was due solely to colour or not, I painted all the bulbs white, and placed them again on the wool; and in nine observations (which were all that I was able to take under a clear sky during a week, owing to the change of the weather at the beginning of this present month) I obtained the following results:—

That the red-spirit was lower by 0°·2 than either of the uncoloured thermometers, instead of being 0°·3 in excess of them (this I expected, from its having a somewhat smaller bulb); that the Scotch black-bulb was 0°·1 instead of 0°·6 higher than the average of the two English thermometers; that the ordinary mercurial minimum still agreed nearly with the sensitive spirit thermometer, but that the difference between it and the black-bulb mercurial was diminished by 0°·4. Assuming, then, the results of the last experiments to represent accurately the comparative sensitiveness of the thermometers, which if I had been able to make more observations would probably have been exactly the case, I find, by subtracting these differences from those formerly observed, the following excess of reading on wool, due apparently to colour:—

Red-spirit	0°·6
Scotch black-bulb	0·5
Black-bulb mercurial minimum	0·4

This is of course but an approximation, but it shows that some difference exists due to this cause. I may mention that red spirit is very nearly as absorptive of the sun's rays as a black bulb.

If the lowest readings registered during the whole night are taken alone, the results are not materially different from those of the first series of observations, but the difference between the thermometers is more irregular—on some nights the excess of the less-sensitive thermometers being great, and on others amounting only to half a degree.

The conclusions which I venture to draw from these experiments are—

1. The ordinary pattern of standard radiation minimum is far from being sufficiently sensitive to register accurately the extremes of temperature either on wool or grass.

2. The Scotch pattern has no advantages over ours, but rather the contrary, as it approaches less nearly to the true temperature of the wool or grass, differing from it by a quantity that varies with the material much more than is the case with ours. Moreover it would be liable to fracture if left in the sun all day, unless made with a very extended range.

3. The same remarks apply to coloured-spirit.

4. I should not recommend the adoption of the mercurial minimum, owing to the great care and trouble involved in placing it correctly on an uneven surface, although it works admirably on a thermometer-stand. If the bulb be ever so little inclined downwards, it will sometimes register 5° or so too low—an error which will not be so easily detected if it be used alone as it would be detected when the mercury runs quite down into the bulb.

5. A spirit minimum can be made which shall register the extremes of temperature on either wool or grass with almost perfect accuracy, one of which instruments Mr. Casella has recently made for me.

In conclusion, let me express a hope that something will really be done to make observations of the amount of radiation both accurate and comparable, and to render more uniform the differing arrangements for ascertaining it. If this Society, or some influential Members of it, would take the matter up, I should be amply repaid for the time and pains I have spent in drawing attention to this subject.

CXXIII. *On the Prevalence of Rain in the North Atlantic, South Atlantic, and a part of the North Pacific Oceans.* By FREDERIC GASTER, Esq., F.M.S.

[Three Plates.]

IT seems quite unnecessary at the present time to speak of the importance of gathering and discussing as far as possible all reliable statistics which can be obtained respecting the prevalence of rain in all parts of the world; and though we may premise that a knowledge of the actual amount which falls is to be sought for in preference to other details, yet, in parts from which this information cannot be obtained, some particulars respecting the frequency of rain falling (or its comparative prevalence in various parts) cannot fail to be of value.

This seems to have been recognized some years since by Captain Maury, who for a considerable time was Director of the Observatory at Washington, U.S., and who furnished nautical men and meteorologists with so much valuable information respecting the prevalence of different winds in various parts of the world, and the weather which most frequently accompanied those winds and their changes.

In supplying such information, a variety of charts were prepared, and among them "storm and rain charts" for some portions of the ocean.

The following is Maury's own description of the charts referred to, and is given because it is better, before offering any remarks on what has been done with the observations contained in them, to see clearly on what authority and in what manner the collection of them was made.

"The object of these charts," he says, "is to show the total number of observations that have been discussed for each month in every space of 5° square in the ocean, and then to show for every square and month the number of days in which there was rain, a calm, a fog, thunder and lightning, or a storm and the quarter from which it blew."

"The ocean is divided into districts of 5° of latitude by 5° of longitude for these investigations; and whatever phenomenon is reported as occurring in one part of a district is assumed to occur in all parts of that district."

He then explains that the figures in the column marked "days" do not give the number of *days*, but of eight-hour periods in which observations have been made, and the other figures the number of such periods (or "observations") in which the particular (or "exceptional") phenomena referred to were noted.

Thus we are supplied with a vast number of figures giving the total observations of all weathers which have been collected for each month in every square, and the number of those observations in which rain (or other phenomena) were noted as prevailing.

A great drawback to the charts is, however, the difficulty of referring to them in order to obtain readily the comparative prevalence of the rain &c. between square and square, the number of eight-hour periods collected in one square differing frequently so much from those collected in another that some little calculation is necessary before the facts observed in the two regions can be compared with each other.

To remedy in some degree this defect, an endeavour has here been made to obtain the total number of observations of all weathers made in each square for the whole year, and to calculate the percentage of those observations in which rain has occurred. In this way means are afforded for seeing at a glance in what districts rain is more or less prevalent, and for noticing whether any, and what, rules may apply to the distribution of rain over the ocean's surface. The monthly variations from the values so obtained will be considered in a subsequent paper; and it is hoped to treat the observations of calm, fog, and thunder and lightning in a similar manner.

The total number of observations used in forming the Tables appended to this paper is 349,770, of which 158,142 are in the South Atlantic, 107,191 in the North Atlantic, and 84,167 in the North Pacific between America and longitude 150° W. The observations are all made between the equator and latitude 60° in each ocean; and in Tables I., II., and III. the percentage in each 5° square is given, together with the number of observations from which it was obtained, and the number of months in which they were made. The latter figures are given in order to show the value to be attached to the percentage. On the chart, which is ruled off into 5° squares, those percentages (to the nearest 1 per cent.) marked in ordinary Arabic numerals (*e.g.*, 12) are obtained from observations made in all twelve months of the year, and those in thick-faced (*e.g.*, **20**) from observations in from nine to eleven months; values obtained from less than nine months are left out of the chart*, though given in the Tables. The mean percentage has also been calculated for each zone of 5° of latitude in each ocean, and also for each 5° of longitude, and diagrams representing the variations in their values are given.

On glancing at the chart, one cannot fail to be struck with the high percentage of rainy weather in the North Atlantic when compared with that in the South, an excess on which Maury bases his theory of the "crossing of the trades" at the equatorial calm-belt,—the north-east trade wind becoming, he believes, the north-west "antitrade" or "passage wind" of the southern hemisphere, and the south-east trade the south-west "antitrade" of the northern hemisphere. Unfortunately the publication of the charts ceased after the one for a portion of the North Pacific came out; so that it is impossible to say whether the same difference exists between the South and North Pacific. It would appear, however, that rain is much more frequent in the North Pacific than in the South Atlantic, the mean percentage for the three oceans being, South Atlantic 6·4, North Atlantic 10·9, and in that portion of the Pacific for which observations are published (in this case between the equator and lat. 45° N.) 9·3. Above lat. 45° N. the observations in this ocean are mostly confined to certain months near and in the summer, and the percentage obtained from them is 9·2.

The great evenness in the prevalence of rain in the South Atlantic is worthy of attention, and the existence of a belt across the ocean between lat. 35° and 40° S., in which the percentage varies but little from 6, is very marked. The mean percentage of this belt is 5·8, and is obtained from 31,631 observations. There would appear also to be a gradual increase in the prevalence of rain in going from the eastern towards the western side of the ocean; and the high percentage in the neighbourhood of Cape Horn is clearly shown. Unfortunately here, again, there are no observations to the southward of lat. 40° S. in other parts of the ocean, so that we cannot see whether this high percentage exists right across the ocean, or is peculiar to the neighbourhood of Cape

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* Except in some cases in the North Pacific, above lat. 45° N.

Horn. The prevalence of rain on the eastern side of the south-east trade-wind region is very slight, in no case exceeding 3 per cent.; while down the western side of the ocean 8, 9, and even 10 per cent. may be found.

In the North Atlantic things are different, the atmosphere there appearing, as Maury says, "in a much less stable condition" than to the southward of the equator. Nevertheless the increase in the prevalence of rain in going westward may be seen in many places, though masked by other effects when taking the mean for each 5° of longitude (between the equator and 60° N.). The high percentage of rain in the equatorial "doldrums" is very clearly shown; but as the zone of calms moves from north to south and *vice versâ* with the seasons, the effect is somewhat lessened by taking the mean for the whole year. The extreme northern and southern limits of the equatorial doldrums are marked in on the chart by dotted lines; and it would almost seem at first sight as though the zone of most constant precipitation, both here and in the North Pacific, falls slightly to the northward of the zone of calms. Some correspondence, too, appears to exist between the position of the Gulf-stream and a region of great prevalence of rain; but it is not attempted here to go into details on the subject; it is hoped that another and more minute paper may shortly be ready, when, the prevalence of other phenomena being combined on a similar principle with that of rain, some conclusions may be more easily and safely arrived at.

In examining the North Pacific, we meet with additional difficulty from the fact that the observations are not at all equally distributed over the different months of the year (particularly above lat. 45° N.); so that the prevalence in the latter-named district would appear, from what records are given, to differ nothing from that in the other parts of the ocean,—a state of things very different from what is observed either in the North or South Atlantic, and perhaps differing, too, from what one would naturally expect to find. The variations in the different months may, however, throw more light on this question, though the number of observations in some regions is too small to give reliable monthly percentage values.

It is hoped, nevertheless, that what the present Tables show may in itself be worth something, and that that value may be much increased when they are more fully developed and discussed.

TABLE I. Prevalence of Rain in each Square of 5° Latitude and Longitude in the SOUTH ATLANTIC.

Longitude.	Lat. 0°–5° S.			Lat. 5°–10° S.			Lat. 10°–15° S.			Lat. 15°–20° S.			Lat. 20°–25° S.			Lat. 25°–30° S.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.
15°–20° E.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15	3	6·7
10–15	...	...	...	24	2	4·2	...	...	...	...	...	...	30	6	6·7	561	12	2·1
5–10	12	3	0·0	15	1	6·7	...	...	...	39	3	0·0	363	12	2·8	1,569	12	1·7
0– 5 E.	27	2	0·0	18	3	0·0	15	3	6·7	192	8	0·4	1,569	12	1·2	462	12	3·0
0– 5 W.	15	3	0·0	6	1	0·0	33	4	0·0	1,545	12	2·1	861	12	5·0	231	7	5·2
5–10	60	5	5·0	18	2	0·0	753	12	2·5	1,362	12	4·8	156	10	3·8	141	9	5·0
10–15	90	5	0·0	300	11	3·0	1,458	12	4·0	303	12	11·2?	69	6	0·0	213	10	3·3
15–20	579	12	3·1	1,149	12	2·2	798	12	3·9	153	10	3·9	195	8	3·6	594	12	5·7
20–25	2,079	12	6·1	1,674	12	4·5	414	12	1·7	363	12	3·6	770	12	4·0	1,200	12	6·9
25–30	3,546	12	7·3	2,199	12	3·0	1,444	12	2·9	1,812	12	4·5	2,574	12	6·7	1,791	12	6·0
30–35	2,451	12	8·9	4,094	12	7·8	3,780	12	4·7	3,412	12	6·8	2,789	12	7·5	2,119	12	7·8
35–40	1,635	12	11·7	273	12	3·7	1,011	12	6·2	3,941	12	7·1	3,323	12	7·0	2,223	12	10·0
40–45	85	9	7·1	...	...	...	...	...	...	...	...	...	1,313	12	4·1	2,193	12	7·8
45–50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	884	12	8·6
50–55	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
55–60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
60–65	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
65–70 W.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Totals & Means	10,579	...	7·8	9,770	...	5·2	9,706	...	4·1	13,122	...	5·6	14,012	...	5·6	14,196	...	6·6
Obs. of Rain..	...	825	...	...	509	...	...	397	...	...	741	...	...	785	...	...	943	...

TABLE I. (*continued*). Prevalence of Rain in each Square of 5° Latitude and Longitude in the SOUTH ATLANTIC.

Longitude.	Lat. 30°–35° S.			Lat. 35°–40° S.			Lat. 40°–45° S.			Lat. 45°–50° S.			Lat. 50°–55° S.			Lat. 55°–60° S.			Totals and Means.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Observations of all Weather.	Observations of Rain.	Percentage of Rain.
15°–20° E.	1,500	12	2·1	2,976	12	4·4	141	9	14·9	...	...	...	...	...	...	...	...	...	4,632	185	4·0
10–15	3,232	12	2·3	1,857	12	5·8	159	8	5·7	...	...	...	...	...	...	...	...	...	5,863	205	3·5
5–10	1,968	12	3·2	2,454	12	4·8	490	8	3·9	...	...	...	...	...	...	...	...	...	6,910	237	3·4
0– 5 E.	924	12	5·7	2,442	12	6·1	381	5	10·0	...	...	...	...	...	...	...	...	...	6,030	276	4·6
0– 5 W.	819	12	6·7	2,628	12	6·1	876	4	3·3	...	...	...	...	...	...	...	...	...	7,014	332	4·7
5–10	897	12	6·5	2,085	12	5·8	288	4	1·8	...	...	...	...	...	...	...	...	...	5,760	283	4·9
10–15	1,176	12	6·0	2,064	12	5·9	99	4	0·0	...	...	...	...	...	...	...	...	...	5,772	300	5·2
15–20	1,506	12	6·6	1,570	12	5·5	9	2	0·0	...	...	...	...	...	...	...	...	...	6,553	308	4·7
20–25	1,656	12	6·5	2,145	10	7·4	33	2	0·0	...	...	...	...	...	...	...	...	...	10,334	605	5·9
25–30	1,101	12	6·8	1,045	10	9·7	54	5	7·5	...	...	...	...	...	...	...	...	...	15,566	908	5·8
30–35	1,248	12	7·7	654	12	5·6	99	4	5·0	...	...	...	...	...	...	...	...	...	20,646	1,459	7·0
35–40	1,632	12	9·1	1,485	12	6·7	474	11	9·7	30	6	6·7	...	...	...	...	...	...	16,027	1,295	8·1
40–45	2,397	12	7·8	2,319	12	5·7	1,546	12	6·5	165	11	10·9	...	...	...	...	...	...	10,018	671	6·7
45–50	2,406	12	7·3	3,357	12	6·1	1,974	12	6·7	933	12	7·8	108	12	10·0	...	...	...	9,662	671	6·9
50–55	837	12	6·2	2,046	12	5·1	2,250	12	5·9	1,398	12	6·8	948	12	13·5	27	6	14·8	7,506	516	6·9
55–60	...	...	...	504	12	3·8	2,182	12	5·2	1,875	12	5·5	1,680	12	10·4	405	12	12·6	6,646	462	7·0
60–65	...	...	...	...	...	...	704	12	4·2	2,077	12	5·4	2,781	12	7·3	2,598	12	13·9	8,160	696	8·5
65–70 W.	...	...	...	...	...	...	...	...	...	198	11	4·5	708	12	6·1	4,407	12	16·0	5,313	756	14·2
Totals & Means	23,299	...	5·8	31,631	...	5·8	11,759	...	5·8	6,676	...	6·2	6,225	...	9·0	7,437	...	14·9	158,412	10,165	6·4
Obs. of Rain..	...	1347	...	...	1850	...	...	686	...	...	413	...	...	560	...	...	1109	...	......	...	...

TABLE II. Prevalence of Rain in each Square of 5° Latitude and Longitude in the NORTH ATLANTIC.

Longitude.	Lat. 0°–5° N.			Lat. 5°–10° N.			Lat. 10°–15° N.			Lat. 15°–20° N.			Lat. 20°–25° N.			Lat. 25°–30° N.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.
5°– 10° E.	222	5	10·8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0– 5 E.	98	7	8·1	55	2	1·8	...	...	...	...	...	...	...	...	...	...	...	...
0– 5 W.	233	11	12·4	70	5	4·3	...	...	...	...	...	...	...	...	...	...	...	...
5– 10	362	12	14·4	80	6	17·5	...	...	...	...	...	...	...	...	...	...	...	...
10– 15	107	8	11·2	716	11	22·8	...	...	...	...	...	...	...	...	...	...	...	...
15– 20	335	11	11·3	483	11	13·5	225	9	4·9	6	1	0·0	15	4	0·0	87	9	8·0
20– 25	1,262	12	11·5	1,109	12	18·7	662	12	7·9	159	11	0·6	136	12	0·7	151	9	4·6
25– 30	2,004	12	15·6	1,667	12	15·4	833	12	5·9	638	12	4·4	338	12	4·4	209	11	6·7
30– 35	1,004	12	17·8	739	12	15·6	667	12	6·1	711	12	3·4	664	12	5·1	663	12	6·6
35– 40	613	12	13·4	632	12	15·7	415	12	9·6	449	12	5·2	805	12	6·7	958	12	9·8
40– 45	421	11	21·4	668	12	16·3	508	12	11·4	302	11	11·6	452	12	11·1	726	12	7·8
45– 50	95	7	9·5	289	11	13·5	594	12	6·9	326	12	5·5	262	12	8·4	564	12	9·9
50– 55	...	...	...	...	...	...	387	12	4·8	541	12	5·2	267	11	7·1	351	12	5·4
55– 60	...	...	...	23	3	13·1	96	10	1·0	459	12	7·4	637	12	3·9	394	12	9·1
60– 65	...	...	...	...	...	...	53	6	7·5	183	10	7·7	650	12	7·5	948	12	7·7
65– 70	...	...	...	...	...	...	48	3	0·0	152	10	5·3	262	12	8·4	1,137	12	8·7
70– 75	...	...	...	...	...	...	...	...	...	320	12	5·9	380	12	8·2	1,393	12	7·0
75– 80	...	...	...	...	...	...	65	8	15·4	243	11	7·8	316	12	5·7	1,945	12	7·2
80– 85	...	...	...	...	...	...	69	4	2·9	102	9	2·9	1,482	12	3·7	573	12	6·5
85– 90	...	...	...	...	...	...	...	...	...	...	...	...	304	11	2·6	1,132	12	8·2
90– 95	...	...	...	...	...	...	...	...	...	25	3	8·0	88	9	1·1	114	10	7·0
95–100 W.	...	...	...	...	...	...	...	...	...	81	9	11·1	29	5	17·2	22	3	0·0
Totals & Means	6,756	...	14·8	6,531	...	16·5	4,622	...	7·0	4,697	...	5·6	7,087	...	5·8	11,367	...	7·7
Obs. of Rain..	...	1001	...	...	1075	...	...	324	...	...	265	...	...	409	...	...	881	...

TABLE II. (*continued*). Prevalence of Rain in each Square of 5° of Latitude and Longitude in the NORTH ATLANTIC.

Longitude.	Lat. 30°–35° N.			Lat. 35°–40° N.			Lat. 40°–45° N.			Lat. 45°–50° N.			Lat. 50°–55° N.			Lat. 55°–60° N.			Totals and means.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Observations of all Weather.	Observations of Rain.	Percentage of Rain.
5°– 10° E.	...	...	...	12	2	16·7	...	...	...	...	...	...	...	...	...	...	...	...	234	24	10·3
0– 5 E.	...	...	...	9	1	11·1	...	...	...	...	...	...	...	...	...	...	...	...	162	10	6·2
0– 5 W.	...	...	...	225	10	3·6	...	...	...	313	12	6·1	583	12	11·1	30	4	16·7	1,454	129	8·9
5– 10	3	1	0·0	334	11	1·8	67	6	6·0	920	12	7·1	1,393	12	10·3	78	9	3·8	3,237	288	8·9
10– 15	77	10	5·2	340	12	4·4	128	8	3·9	1,321	12	11·0	1,260	12	11·0	117	11	19·7	4,066	505	12·4
15– 20	223	11	6·3	302	12	7·0	168	9	10·1	1,478	12	12·4	932	12	17·5	123	8	8·9	4,377	551	12·6
20– 25	129	9	7·0	268	11	9·0	269	12	8·6	1,439	12	13·9	850	12	15·4	102	7	7·8	6,536	805	12·3
25– 30	175	10	5·1	341	11	7·3	396	12	8·1	1,627	12	14·7	694	12	16·1	60	5	15·0	8,982	1,101	12·3
30– 35	402	12	7·7	242	12	9·5	732	12	11·1	1,738	12	14·8	510	12	10·8	...	...	...	8,072	884	11·0
35– 40	747	12	9·2	349	12	8·9	1,119	12	11·4	1,570	12	17·0	420	12	19·3	...	...	...	8,077	968	12·0
40– 45	893	12	6·7	480	12	12·8	1,582	12	16·4	1,242	12	19·2	150	9	23·3	...	...	...	7,424	1,052	14·2
45– 50	986	12	7·5	773	12	13·2	1,863	12	13·8	910	12	15·3	...	...	...	...	...	...	6,662	761	11·4
50– 55	840	12	8·5	1,100	12	12·6	2,419	12	13·9	288	12	11·5	...	...	...	...	...	...	6,193	664	10·7
55– 60	723	12	12·2	1,393	12	13·5	2,679	12	12·7	126	10	16·7	...	...	...	...	...	...	6,530	736	11·3
60– 65	756	12	8·1	1,797	12	11·6	2,544	12	12·1	...	...	...	...	...	...	...	...	...	6,931	717	10·3
65– 70	1,645	12	9·8	2,974	12	9·1	3,250	12	10·5	...	...	...	...	...	...	...	...	...	9,468	903	9·5
70– 75	2,265	12	9·8	4,193	12	12·0	1,820	12	8·5	...	...	...	...	...	...	...	...	...	10,371	1,026	9·9
75– 80	1,534	12	8·9	243	12	6·2	...	...	...	...	...	...	...	...	...	...	...	...	4,346	338	7·8
80– 85	48	6	6·4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,274	100	4·4
85– 90	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,436	101	7·0
90– 95	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	227	11	4·8
95–100 W.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	132	14	10·6
Totals & Means	11,446	...	8·9	15,375	...	10·7	19,036	...	12·0	12,972	...	13·9	6,792	...	13·6	510	...	11·6	107,191	11,688	10·9
Obs. of Rain..	...	1015	...	...	1642	...	...	2287	...	...	1807	...	...	923	...	...	59	...	...	...	...

TABLE III. Prevalence of Rain in each Square of 5° Latitude and Longitude in the NORTH PACIFIC.

Longitude.	Lat. 0°-5° N.			Lat. 5°-10° N.			Lat. 10°-15° N.			Lat. 15°-20° N.			Lat. 20°-25° N.			Lat. 25°-30° N.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.
75°– 80° W.	925	12	16·9	192	10	19·8	...	...	...	...	...	...	...	...	...	...	...	...
80– 85	3,573	12	12·1	387	10	16·0	...	...	...	...	...	...	...	...	...	...	...	...
85– 90	1,773	12	8·9	537	11	14·2	153	9	3·3	...	...	...	...	...	...	...	...	...
90– 95	2,694	12	7·3	216	10	14·8	333	10	4·2	30	5	16·7	...	...	...	...	...	...
95–100	864	12	8·9	366	12	22·7	438	10	8·4	219	11	4·2	...	...	...	...	...	...
100–105	906	12	12·1	891	12	19·5	531	12	7·7	707	12	3·3	...	...	...	...	...	...
105–110	999	12	10·3	1,073	12	29·1	741	12	22·3	561	12	10·9	775	12	2·2	...	...	...
110–115	1,362	12	6·5	1,659	12	23·4	1,266	12	22·3	765	12	8·6	837	12	2·9	192	11	1·0
115–120	1,404	12	8·4	1,605	12	22·1	1,719	12	17·2	1,200	12	8·7	856	12	3·0	690	12	1·9
120–125	936	12	7·2	615	12	17·9	927	12	14·0	1,398	12	5·1	1,108	12	2·9	1,074	12	2·5
125–130	672	12	4·8	318	11	15·4	264	11	12·5	867	12	5·3	1,398	12	3·0	1,386	12	5·8
130–135	700	11	6·1	360	11	18·6	237	11	8·9	249	12	6·0	783	12	4·5	2,088	12	5·1
135–140	396	10	4·0	278	11	19·4	276	10	6·2	222	10	5·0	285	12	6·7	1,016	12	4·7
140–145	273	10	11·4	251	11	19·9	213	9	10·8	368	12	9·8	435	12	7·6	645	12	12·1
145–150 W.	378	11	7·4	303	11	20·1	213	11	9·4	534	12	8·1	621	12	7·2	558	12	9·5
Totals & Means	17,855	...	9·3	9,051	...	21·2	7,311	...	14·8	7,120	...	6·9	7,098	...	3·8	7,649	...	5·3
Obs. of Rain..	...	1659	...	...	1921	...	...	1085	...	...	492	...	...	273	...	...	409	...

TABLE III. (*continued*). Prevalence of Rain in each Square of 5° Latitude and Longitude in the NORTH PACIFIC.

Longitude.	Lat. 30°-35° N.			Lat. 35°-40° N.			Lat. 40°-45° N.			Lat. 45°-50° N.			Lat. 50°-55° N.			Lat. 55°-60° N.			Totals and Means.		
	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Number of eight-hourly observations.	Months.	Per cent. of Rain.	Observations of all Weather.	Observations of Rain.	Percentage of Rain.
° ° 75- 80 W.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,117	194	17·4
80- 85	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,960	496	12·6
85- 90	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,463	239	9·7
90- 95	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,273	248	7·6
95-100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,887	206	10·9
100-105	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,035	348	11·5
105-110	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4,149	659	15·9
110-115	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6,081	855	14·1
115-120	333	12	2·7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7,807	929	11·9
120-125	1,260	12	2·6	2,256	12	5·1	15	2	13·3	18	3	44·4	...	...	...	...	...	...	* 9,589 18	588 8	6·1 44·4
125-130	2,256	12	5·7	1,827	12	6·6	147	9	8·8	123	6	16·3	6	1	0·0	...	...	...	* 9,135 129	545 26	4·9 12·4
130-135	2,442	12	5·2	1,108	12	4·2	213	10	14·1	84	6	6·0	294	5	10·9	24	2	12·5	* 8,180 402	490 40	6·0 10·0
135-140	1,467	12	5·9	1,071	12	5·3	198	9	9·1	182	7	8·2	987	7	7·3	579	7	13·3	* 5,209 1,748	326 164	6·3 9·4
140-145	732	12	7·2	510	11	7·8	312	10	10·9	189	7	7·4	1,335	6	7·7	2,028	5	9·4	* 3,739 3,552	377 308	10·1 8·7
145-150 W.	426	11	6·8	543	11	8·7	315	10	8·6	402	7	6·7	2,616	6	8·5	1,785	6	10·4	* 3,891 4,803	353 434	9·1 9·0
Totals & Means	8,916	...	5·2	7,315	...	5·8	1,200	...	10·3	*998	...	8·9	*5,238	...	8·3	*4,416	...	10·3	* 73,515 10,652	6,853 980	9·3 9·2
Obs. of Rain..	...	464	...	...	427	...	...	123	...	...	89	...	...	435	...	...	456	...	...	...	...

* The observations between lat. 45° and 60° N. were made almost exclusively in the summer months; and as the number of them is large, two means and two sets of totals have been obtained,—one (the upper) for the regions between 0° and 45° N., and the other (the lower) for latitudes between 45° and 60° N. For this reason it also follows that the means at the bottom of each of the 5° columns 45°-60° N. show rather the percentage of rainy weather during the *summer*, than during the whole year, in those latitudes.

CXXIV. *Leading Features of the Climate of Natal, South Africa.*

By R. MANN, Esq., M.D., F.M.S., Superintendent of Education in the Colony.

IN presenting this paper, I propose to bring the leading features of the results at which I have arrived briefly under the notice of the Society, stating at the same time that there are several points in connexion with them to which I propose to draw special attention on other, more fitting occasions.

It will be seen by the aid of maps and plans, that Natal is placed but a short distance without the southern tropic—that it is therefore a subtropical land. The landward frontier of the colony is formed of a lofty mountain step, or ledge, termed the Drakenberg, which lies in a triple zigzag, constituting a retiring bay and a projecting point, and ranging at a distance of from 100 to 130 miles from the sea. The mountain ledge has an average height of between 5000 and 6000 feet above the sea; but it is jagged, and its jags or peaks rise to between 7000 and 9500 feet. The opposite frontier, or coast-line, has an extent of about 150 miles. The land between this high mountain ledge and this low coast-line is the colony of Natal, having an area about as large as the eastern and midland counties of England lying eastward of the meridian running through Salisbury and Birmingham, and southward of the parallel of Nottingham.

At the projecting point of the mountain ledge, where a natural embattlement in rockwork bears the not inappropriate name of the Giant's Castle, a subordinate ridge begins. This ridge sets down into Natal, but it forks as it goes, having one branch to the left, on the Tugela River, the north-eastern boundary of the colony below, and another branch to the right on the large Umkomanzi River, which itself rises in the mountains. Between these extreme branches of the fork three other prongs or fingers are also formed, thus converting this system of ridges into a five-fingered hand, the tips of the fingers lying on the sea, and four secondary rivers, the Umvoto, the Umgeni, the Umlazi, and the Ilovo, draining down in the grooves between the fingers. The main branch of the ridge, the little finger, after shooting forth from the salient point of the Drakenberg, curves round quite across the central tract of the colony, and then bends along its northern frontier river, until it is lost near the river's mouth in the sea, thus in reality forming the high backbone of the land; in other words, the little finger of the hand is bigger and higher than the other fingers or the thumb, and is also distorted into a serpentine sweep. The meaning of all this is that when the Drakenberg was formed, the cracks and disturbance radiated from its salient point outwards, like the rays of a fan, and framed, as the great central tract or basin of the colony, a river-system in which the hill-ranges and the watercourses are divergent. In this basin or system twelve smaller and shorter rivers flow down to the sea from clefts and grooves of the extremities of the fingers, in addition to the four more notable rivers that have been named. This central basin of Natal may therefore be designated the basin of the radiant and manifold rivers.

To the north of this central basin an arrangement of an exactly opposite kind is found. From the retiring bay of the Drakenberg, the subordinate ridges on either hand are collected together, but do not quite meet; river-channels are left between their terminal points, or buttresses; and these river-channels all finally gather into one common stream, which for the last fifty miles becomes the north-eastern boundary of the colony. The river-system in this northern basin is convergent, instead of radiant, and one great stream, instead of many streams, is ultimately formed. The Buffalo River, Sunday River, Klep River, Central Tugela, Bushman River and Mooi River, are drawn together into the Lower Tugela. The entire basin or area drained by this one river is quite equal in extent to the central district previously described as being the supply of sixteen rivers. The main portion of the colony of Natal is thus naturally distributed into two great river-systems,—the Tugela Basin, a one-rivered system with a convergent water-shed and a solitary outlet on the sea; and the central basin of the many rivers, a divergent system with many outlets on the sea. To the south-west of the central many-rivered basin, there is yet another river-basin, lying in Natal, the basin of the river Umkomansi, which comes down direct from the Drakenberg mountains to the sea, and which has again, beyond it, one other similar basin—that, namely, of the long river Umsimkulu, also a mountain-born river. These two river-basins comprise a quadrangular tract of land, which lies to the south of the central many-river basin, and so forms a third great natural division of the colony. Until recently the second river, the Umsimkulu, was the south-eastern boundary of the colonial territory, only one-half of its basin being comprised within British domain; the further half of this basin is now, however, added to the colony under the designation of the county of

Alfred (Nomansland), excepting that its upper portion is reserved for the occupation of the Griquas.

The subordinate ridge which sets off from the salient point of the Drakenberg, and crosses the central region of the colony as the left fork or little finger of the many-river basin, is really the highest part of the land between the Drakenberg and the sea; it is properly the backbone of the colony. Further to the north the land again dips somewhat in the Tugela basin. The highroad from the sea-port to the mountains crosses this ridge at an elevation of a little more than a mile, where it is seventy miles from the sea. The capital city, Maritzburg, stands at about four-sevenths of this distance, with an elevation of 2090 feet.

It will be observed, in the meteorological abstract, that during the last year the wind was blowing at the time of observation 820 times from the sea up this rapid land-slope, and 145 times down the slope towards the sea. The prevalent wind is a sea wind, and this wind blows up an incline which lifts it a mile high in a course of seventy miles. This is, in fact, the broad base of the colonial climate. The almost constant sea wind is in part a trade wind; but the trade influence is reinforced and strengthened by a monsoon influence. That Natal, in the parallel of 30° south latitude, is really in the trade-wind region at certain seasons of the year is unquestionable. The writer of this memorandum left the Cape of Good Hope, which lies in the parallel of 34° south, in the month of April in the present year, in the mail steamer 'Saxon.' The steamer sailed from Robin Island, situated immediately off the entrance of Table Bay, with a strong steady south-east wind, and this wind never intermitted for a single instant until the equator was passed. It is obvious that Natal in 30° latitude must be more or less within the range of this great atmospheric set. But in addition to this, the land of Natal is heated by day by a blazing sun, which so rarefies the atmosphere lying upon it as to cause the land air to give place constantly before the heavier sea breeze.

During the winter season (that is, from April to September) the normal atmospheric current is gentle and steady; the natural set of the air is rarely interrupted: there is at this season clear sunshine day after day, the temperature rising at Maritzburg to somewhere about 72° in the day, and sinking to somewhere about 50° at night. It will be observed in the abstract of the Register that there were last year only eight days in the entire year on which the temperature did not rise to 60°, and there were eighty-one nights on which the temperature fell below 50°. During this winter season of sunshine the rainfall is very slight. There are two midwinter months, June and July, in which there are three and a half days monthly in which rain falls, and in which the monthly fall amounts to only $\frac{7}{10}$ of an inch. Before and after these midwinter months there are two months in which rain falls on eight days and three-quarters, and in which the monthly rainfall is $1\frac{4}{10}$ inch. In the summer season (that is, from October to March) there are six months in which the rain falls on fifteen and a half days for each month, and in which the monthly fall amounts to 4 inches; 24 inches out of 30 inches falls in Maritzburg during the six months of the summer season.

The reason for this increase of rainfall in the summer season is that at that period of the year the normal current of the atmosphere is frequently broken for brief intervals, as a natural consequence of the increased force of the monsoon influence. The nearly vertical rays of sunshine at that time heat the ground so intensely that, soon after noon, the normal set of the atmosphere is changed, on the higher portion of the slope, into a strong chimney-like upcast of rarefied air. Where this air ascends, latent vapour is turned into sensible mist and cloud, and electrical force set free. It will be observed that at Maritzburg there are forty-one thunderstorm days in the summer six months, against ten thunderstorm days in the winter six months, and that in addition to this there are ten other days on which lightning is seen, or, in other words, on which there are thunderstorms occurring within a few miles. Thus there is a thunderstorm at Maritzburg during the summer season on nearly every third day. The rule at this season of the year is, that dense clouds collect early in the afternoon, and that rain, generally accompanied by lightning-discharges, pours down for a longer or shorter interval, the sky continuing to be shrouded far into the night. One immediate consequence of this almost constant afternoon cloud and frequent rainfall is, that the heat rarely rises to what might be anticipated from the subtropical position. It will be noticed that there are only forty-nine days in the year on which the temperature exceeds 84°, and only twelve days on which it exceeds 90°. The general midsummer range of afternoon temperature at Maritzburg may be taken to be about 85° when the hot wind is not blowing.

The great law for the range of temperature in Natal is, that it varies greatly between day and night, and that it is very steady from day to day during the dry winter season, and that it varies little between day and night, but greatly from day to day, during the wet summer season. If the range of temperature for the two opposite seasons is laid down upon paper as a kind of picture, the winter picture presents a broad even sweep or zone, and the summer picture presents a narrow jagged sweep or band, somewhat resembling a range of alpine mountains.

The barometer at Natal is in incessant movement. It marks a small daily wave of the atmosphere of about $\frac{8}{10}$ of an inch; but in addition to this there are broad undulations continually sweeping along day after day, within an extreme range of an inch and a quarter. From four to seven or eight of these larger waves pass in the course of a month. These waves are unquestionably due to an alternating flow of the atmospheric current. When the general mass of the air is moving from the north-west to the south-east, the barometer rises; when the movement is in the opposite direction, from the south-east to the north-west, the barometer falls. In other words, the normal atmospheric current of the surface from the south-east generally prevails; but the opposite compensatory current of the higher atmospheric region periodically bears down upon the surface for a brief interval, and for the time overpowers its inferior but generally stronger antagonist. The general set of these antagonistic currents is not necessarily marked at the surface by the vane; there is often a thin low current moving in a different direction from the general mass of the air. The barometer is a more exact and accurate indication of the movement than the vane.

In the extreme case of the upper or north-west current attaining its fullest development at the surface, it constitutes what is familiarly known as the "hot wind." The "hot wind" of Natal is a very violent one. It blows with great turbulence and force, sweeping clouds of dust along the ground. When it is blowing, the temperature rises to somewhere between 86° and 97° of Fahrenheit's scale, and the air becomes so dry that vegetation shrivels under its touch. The hygrometer commonly indicates 33° of humidity during the hot wind, the mean humidity for Maritzburg for the year being a trifle less than 71°. The hot wind, however, scarcely ever reaches the actual sea-coast; it turns up again into its proper higher domain somewhere about twenty or thirty miles before it reaches the sea. The air is commonly 8° cooler at Durban, the seaport, than it is at Maritzburg when the hot wind is blowing at the latter place. The hot wind occurs in the lowest troughs of the larger atmospheric waves; and during the summer season the thunderstorms happen in the same periods of barometric depression. The storms break just when the mercury of the barometer begins to rise after its lowest fall. There is no doubt that the hot winds of Natal are intimately connected with the north-west gales of the South Atlantic, occasionally so destructive at the Cape of Good Hope. On the 17th day of May in last year (1865) there was a very severe gale at the Cape, during the height of which several vessels were destroyed, among them the mail steamer 'Athens,' which was engulfed in the sea when striving to steam out from the anchorage, with every living creature that it contained. On the 16th and 18th there was a furious hot wind blowing at Maritzburg, and on the 18th the atmospheric wave dipped to its lowest trough. The wave began to sink on the 10th from $28\frac{1}{10}$ inches of the mercurial column, and continued to fall during eight days, after which the mercury was standing nearly at $27\frac{6}{10}$ inches; the wave then rose rapidly during nearly four other days, to the next crest, when the mercury was standing above $28\frac{3}{10}$ inches. The greatest force of the gale obviously fell upon Natal about twenty hours later than it fell upon the meridian of the Cape; and this was simultaneous with the development of a violent hot wind. The wind was blowing from the south-east with the antecedent crest of the atmospheric wave. It veered to the north and south-west on the 12th and 13th. On the 14th it was blowing east and south-east. On the 15th it was north-east in the morning, south-west in the afternoon, and north-east in the evening; the next day it was again round to the south-west. It then veered through south-east to north-west during the approach of the crisis of the hurricane, and afterwards returned to east and south-east. There was much, in these opposite movements of the wind during the three days before the crisis, that looked like a double cyclone. But it may be at once stated that the violent hot winds of Natal do not *ordinarily* assume this character. The wind begins to blow suddenly from the north-west in the early morning, without any other premonition than the falling of the mercury in the barometer; and then towards the middle of the day it lulls as suddenly, and a few minutes afterwards a fresh breeze sets in from the south-east. In all probability, when these strong conflicts and reversals of the atmospheric currents occur, cyclonic hurricanes are in some degree associated with them; but the whirlwinds should be looked for at the borders of the great air-stream, where the conflicting currents encounter each other, rather than in its midst. It is a question whether the hot wind of Natal is not rather the great moving mass which orginates cyclones upon its outer border, than a cyclone in its own right.

It will be seen that the hot wind blows in Maritzburg about twenty-five times in the year upon an average. Its duration is generally restricted to a few hours: very rarely it blows on two or three days in succession, and then almost always intermits in the afternoon and early night.

Rain occurs in Natal with both a high and a low barometer. The rain with the low barometer is the thunderstorm-rain of the summer season; this is often heavier in the uplands than it is on the coast. The rain of the high barometer is a sea-rain, and often associated with sea-gales. This occurs both in summer and winter, and is always heavier on the coast than in the uplands. It often amounts to not more than a heavy mist on the high grounds of the midregion of the colony. In the dry month of June in the year 1865, the writer of these notes was stopped for seven days between two small rivers on the coast by their suddenly rising from a depth of a few inches to flood height, and was finally constrained to head his course upwards along the crest of land between the streams. The rainfall on the coast amounted during these seven days to 9¼ inches. The rainfall for the same period at Maritzburg, at a height of 2000 feet, and a distance in a straight line of forty miles from the sea, was only 1·28 inch. In the year 1856 a fall of a similar character, but of much greater amount, occurred in the month of April. On this occasion the fall occasioned a devastating flood along the coast. The heaviest rainfall within twenty-four hours during the last eight years was two inches. Upon one occasion only, an inch fell at Maritzburg within the hour.

It will be noticed that during six months of the year 1865, the rainfall at Durban amounted to twice the rainfall of Maritzburg. This, however, was somewhat exceptional. The rainfall of the coast generally exceeds the rainfall of Maritzburg by about one half.

Hailstorms of great violence occasionally occur in association with the thunderstorms. The stones in these heavy storms are angular masses of ice weighing from 2 to 3 drachms. The hailstorm is generally confined to a narrow zone of some two or three miles, but it sweeps along over a great extent of country. Where it goes, it entirely destroys vegetation of every kind. A luxuriant garden is converted into a bare desert in five minutes by these storms. Some districts of the country are more liable to these storms than others; but, on account of the very narrow belt over which the storm rages in violence, the same district is rarely visited a second time until after a long interval. Only one destructive hailstorm has been experienced in the town of Maritzburg during the last eight years.

The observatory at Maritzburg lies at a height of 2095·6 ft. above the sea. At this observatory the mean temperature of the year is 64°·7. The mean temperature of Durban, on the sea-coast, is 3°·5 higher; but Maritzburg experiences greater extremes, both of heat and cold, than Durban. The Durban climate is, in reality, semi-insular; it in a degree approaches to the character of the climate of the Mauritius. Its atmosphere very much resembles that of a moist conservatory. The atmosphere of Maritzburg is more scorching and dry, although moist enough at particular seasons of the year. The extreme range of the temperature in Maritzburg is 62°·5. The human complexion retains much more of red colour in Maritzburg, and on the still higher grounds, than it does on the coast. The climate of the coast is unquestionably relaxing, and prone to generate sallowness and languor after long residence; and this would be very much more the case, but for the frequent prevalence of the comparatively cool and fresh sea-breeze.

ANNUAL GENERAL MEETING.

1866, June 20.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held; and the following Report of the Council was read.

REPORT.

The Council cannot recollect any former time at which the science of meteorology was so systematically pursued as at the present; nor have there at any former occasion been better grounds for congratulation with respect to the progress of the Society. Since the last Anniversary a Charter of Incorporation has been graciously granted by the Queen, and the papers which have been read at our Meeetings have been both numerous and valuable.

Royal Observatory, Greenwich.—In our preceding Reports we have already placed on record the structure of the magnetic basement, and the corresponding command of the temperature of the magnetic instruments; and it suffices to mention that throughout the past year the temperature of the basement has been maintained as near as possible to 59°, summer and winter. The great heats of the summer of 1865, however, tried every arrangement very severely (the temperature of the basement once rising to 71°, and the diurnal range being 4°); and it was found necessary to shade the window-wells and their neighbourhood (the interior and exterior windows being constantly closed), and to sprinkle the upper floor with water. By this caution in summer, and the use of the gas-stove in winter, it is anticipitated that little difficulty will be experienced in keeping the annual variation within about 5°, and the diurnal variation within 3°. The temperature has, in the present month (June), occasionally fallen to 57°.

The basement has been kept perfectly dry throughout the year, except on the following occasion. It is perhaps known that, for conveniently removing the large quantities of water used in the photographic operations, a pump is established in a dry well about 30 feet outside of the Magnetic Observatory, by which the water is thrown at once into a subterraneous drain. In the late spring much soil-water collected itself in this well, and oozed by the side of the suction-pipe into the basement. The pump has now been fitted with the means of exhausting the dry well when necessary; the ground also in the neighbourhood of the Magnetic Observatory has been hollowed into such a form as to throw the rain-water to a distance; and it is now deemed probable that the ground will be made drier than it has ever been before.

Magnetic Instruments.—*Magnetometers.* The upper free declination-magnet was left, at the time of the last Report, without any check on its vibrations, which sometimes became very troublesome. (They could be reduced in Gauss's manner by the use of a hand-magnet; but that course was accompanied with serious objections, shortly to be mentioned.)

A brass bar, vibrating in water, has therefore been attached to its carrier, which effectually controls the vibration of the magnet.

The lower or photographic declination-magnet has a large mirror for photographic records; and a damper (the same which has been in use since 1841), an oval copper ring in the vertical plane, embracing the magnet, with a free interval of about 2 inches all round. Both these magnets are in good order. The upper magnet, it will be remembered, is observed by means of the same theodolite, which can be turned to the circumpolar stars, and thus serves to give independent measures of western declination as zeros for the declination-photographs.

The horizontal-force magnetometer is in good order. This instrument carries a small mirror on which telescope-observations are made for zeros, and a large mirror for photographic records. It has an oval damper.

In our last Report we alluded to some results of observations on the effect of the dampers, based on experiments in which the dampers were slewed through small angles (1° or 2°), from which it was inferred that their magnetic action tended to diminish the apparent disturbances of the magnets by about $\frac{1}{120}$ part—a result applying both to the declination and to the horizontal-force magnetometers. Dr. Lamont suggested that it might be more satisfactory not to slew the damper, but to try the difference of effects of an external disturbing cause with damper in place and damper away. This accordingly was done, an external magnet being mounted so as to produce a disturbance of the magnitude of the largest earth disturbance, and its disturbing effect being measured with the presence and in the absence of the damper. The result was, that no certain difference could be found between the disturbances when the damper was present and when it was away. With the horizontal-force magnetometer the observations were easy, and the results were accordant and decisive; with the declination-magnetometer the observations were troublesome and the results discordant; and it is proposed to repeat the experiments. The damping-rings used on the continent are in the horizontal plane; while those at Greenwich are in the vertical plane, a position which is regarded as very greatly preferable to the other.

The vertical-force magnetometer is furnished with a small mirror for telescope-observations and a large mirror for photography, but, has no damper. It has made its registrations of the variations of vertical force with the utmost beauty and delicacy. Nevertheless a very few dislocations have occurred (two in the present year), of which no certain explanation can be given. In three instances, dislocations in one direction were corrected after a few days by equal dislocations in the opposite direction; and no imperfection in the instrument (such as looseness of screws, &c.) could be found to account for these anomalies. In most, perhaps in all, of the other instances, the dislocations have been caused by carrying a small magnet across the upper room, for the purpose of quieting the upper declination-magnet (before adverted to). It seems as if the induction accompanying this transient passage produced a quasi permanent change in the intensity of the magnetism. In future the instrument will not be exposed to this danger.

The knife-edge was revised by Mr. Simms in December.

The coefficient of thermal change for the horizontal-force and vertical-force magnetometers has not again been investigated, as great doubt appears to attach to the validity of the methods hitherto employed. The photographic registers for the three magnetometers, throughout the year 1865 and up to the present date, are perfect, and are in a forward state of reduction.

The mean magnetic westerly declination for 1865 is about 20°35′.

Earth-current Apparatus.—The apparatus for the registration of spontaneous earth-currents, which was perfectly efficient to January 11, but which was then rendered useless by the destruction of its wires, has, after four months' delay, been again brought (on May 5) to a serviceable state, and the earth-currents have been recorded on every day throughout the periods in which the wires have been continuous. There have been various modifications of the law and intensity of the currents, not yet sufficiently examined; but the following instance deserves special notice.

On examining the photographic sheets of 1865, August 2, we were struck with the indications of spontaneous galvanic currents of extreme violence. At the same time it was found (by the usual public reports) that the time when the signals on the Atlantic telegraph (then in course of immersion) became indistinct coincided exactly with the time when the spontaneous currents began. It appeared therefore almost certain that the apparent fault in the cable was merely a consequence of these powerful currents. Professor William Thomson has furnished a very full statement of what was observed, which seems to establish that there really was a mechanical fault in the cable. The agreement of times, however, must be regarded as one of the most remarkable coincidences that has ever been noticed.

The difference in intensities of the spontaneous currents at different times is very great, as great as the difference of intensities of atmospheric electricity in serene weather and in a thunderstorm. It will be necessary to decide which of these states shall be recorded; for the same instrument will not register both.

On the photograms of earth-current observations, the time-scales are laid down to the end of 1865. It was mentioned in our last Report, that the intensities, in the direction of magnetic north and magnetic west, might be found graphically from those in the directions of Croydon and Dartford, by use of proportional compasses. These compasses have been prepared; but they have not yet been actually used in reductions.

Deflection-instrument.—The mean value of horizontal magnetic force for the year 1865 is about 3·828 in English units, or 1·765 in French units.

Meteorological Instruments.—The meteorological apparatus is in perfect working order. The instruments read by eye to give zeros for self-registering instruments are, barometer, and dry and wet thermometers. Corresponding to them are, barometer and thermometers, photographically self-registering; and Osler's anemometer, mechanically self-registering. Other instruments, self-registering or accumulating, are maximum and minimum thermometers, in the air, for sun-radiation and sky-radiation, and in the Thames; Robinson's anemometer, and Osler's and six other pluviometers at different elevations. All the thermometer-scales have been verified. The movement of the pencil of Osler's pluviometer has been improved by the introduction of a "parallel motion" by Mr. Browning; and a modification of the anemometric portion of Osler's apparatus is at present under preparation, by which the instrument will be made more sensitive to gentle currents of air; and Robinson's anemometer is also being fitted up in such a way as to exhibit a current time-register of the velocity of the wind.

The number of complete revolutions made by the vane of Osler's anemometer in the year 1865, estimated positive in the direction N., E., S., W., was +26·05.

The following Table of the annual rotations of the vane from 1841 to the present time is perhaps interesting. It seems to indicate something like a septennial period. The result given for 1845 is for ten and a half months only.

	1846 + 1·8	1853 − 1·9	1860 − 2·1
	1847 + 11·0	1854 + 6·8	1861 + 16·5
1841 + 5·4	1848 + 12·1	1855 + 10·8	1862 + 13·7
1842 + 13·1	1849 + 23·3	1856 + 16·1	1863 + 28·4
1843 + 20·7	1850 + 15·9	1857 + 14·7	1864 + 17·2
1844 + 21·7	1851 + 19·1	1858 + 24·1	1865 + 26·0
1845 + 8·9	1852 + 8·8	1859 + 14·0	

The anemometer planned by C. O. F. Cator, Esq., which is described in a preceding part of this volume ('Proceedings,' vol. iii. pp. 49–55), has been since March under trial. It has succeeded perfectly in recording pressures of the wind up to 11 lbs., the greatest experienced during this period; and its record of light pressures is extremely beautiful and delicate.

The electrometer is not very perfect; indeed the position of the apparatus for observations of this class is not favourable.

The various meteorological instruments described above have been worked with unceasing regularity.

Special observations for the 'Bulletin' of M. Leverrier were regularly kept up till the general ruin of telegraphs in the month of January cut off the commercial telegraphic communication with London. On April 17, the London District Telegraph Company kindly gave notice that they were again able to transmit messages; and these were immediately resumed.

In the year 1865, the actinometer was used on fifty-eight days, producing seventy-eight observations. It was remarked on one day (September 8) that the rise of the fluid in one minute was sixty-one divisions of the scale. The instrument has been generally in a good state, but appears liable to depart rapidly from perfect adjustment.

The remarkable shower of luminous meteors on 1865, November 13, was well observed, nearly 280 observations having been obtained on the morning of that day, whilst throughout the year 1865 the total number of observations amounted to 395.

The magnetical and meteorological observations are entirely printed, to the extent to which it was proposed to print them, for 1864. It will be remembered that we stated in our last Report that the total interruption of the use of the self-registering magnetometers by the works on the basement during the first half of the year, and the unsatisfactory character of the suspensions in the second half, rendered it necessary to lay aside all thoughts of printing the usual 'Magnetic Indications.' It then became unnecessary to print a large part of the Introduction. In consequence of this diminution of the extent of work, the printing has advanced more rapidly than usual.

The meteorological results admit of being combined in such an infinity of different ways as almost to prevent any one form of further reduction until special demands for it arise: the ordinary reductions of meteorological observations consist for the most part of daily means and other inferences, adapted to the wants of civil life, and printed, in the first instance, in the Weekly Reports of the Registrar-General; but every possible care is taken, in the register of eye-observations, and in the adjustment of zeros on the sheets of self-registering instruments, to place the whole in such a state that they can at once be used for any future investigation. The mass of accurate meteorological observations thus collected, commencing in 1840 (the photographic part beginning in 1848), exceeds probably any other in the world.

GLASGOW OBSERVATORY.—At the Glasgow Observatory a system of meteorological observations has been in operation for several years past. Observations for ascertaining the temperature, moisture, and pressure of the air are taken daily at 9^h A.M. and 9^h P.M. Greenwich mean time. The maximum and minimum temperatures, as indicated under different conditions, are also regularly noted. The establishment is furnished with an Osler's anemometer, which affords continuous indications of the direction and force of the wind. The prevailing direction of the wind from noon to midnight and from midnight to noon, is ascertained daily by a careful examination of the recording sheets. The mean daily pressure of the wind is also derived from the same source by taking the average value of the pressures corresponding to the twenty-four hours of the day. A Robinson's cup-anemometer for ascertaining the horizontal movement of the air has been lately added to the establishment, and has been found to work very satisfactorily. Professor Grant states that in one important respect the institution is imperfect, inasmuch as it is not supplied with a self-registering barometer. He has reason to believe, however, that this defect will soon be remedied.

The great number of disasters which have occurred at sea during the past winter, resulting from the long-continued succession of storms which visited the British Isles and the western shores of the Continent of Europe, has imparted additional interest to the storm-signals which it is usual to transmit from the Board of Trade to the principal maritime towns of the United Kingdom in anticipation of any extensive atmospheric disturbance. Professor Grant has been induced by this circumstance to institute a careful comparison between the storm-signals which were received in Glasgow during the period when the storms were chiefly prevalent, with the corresponding records of Osler's anemometer. The result of this comparison is, on the whole, satisfactory, so far as regards the actual occurrence of the storms predicted. In other words, any abnormal increase in the force of the wind is in general announced beforehand by the storm-signal. The records of the anemometer sheets for the period comprised between 1865, October 8, and March 23, 1866, contain indications of thirty-five storms. Of these, twenty-seven had been announced beforehand by the storm-signals. There occurred, therefore, eight storms which had not been predicted at all. On the other hand, no storm was predicted which had not actually occurred. As regards the direction of the wind, no satisfactory accordance was exhibited between the terms of the storm-signal and the indications of the anemometer.

CAMBRIDGE OBSERVATORY.—The meteorological observations made at the Cambridge Observatory for the year 1865, consisted of daily observations at 9^h A.M. and 3^h P.M. of the barometer and external thermometers (a dry and wet bulb, by Barrow and Co., London, and the self-registrating maximum and minimum, by Messrs. Troughton and Simms)—amount of cloud being indicated by the usual numbers (0–10), and the force of the wind by (0–6); the rain has been measured by means of one of Casella's rain-gauges, at an elevation of 88 feet above the level of the sea, and 9 inches above the ground. The readings have been placed opposite the day of registering, and the yearly amount forwarded to Mr. Symons. A brief report has been sent every week to the 'Cambridge Chronicle' for publication. The readings of the barometer have been corrected for temperature, by means of Mr. Glaisher's Table. During the period of thunderstorms or heavy gales, the reading of the barometer is generally attended to.

The days on which some of the heaviest gales blew, were February 19th, May 30th, November 22nd, December 29th, 30th, and 31st. Thunderstorms, May 9th, 21st and 23rd, June 3rd. On July 7th, 11½^h A.M., "a few flashes of lightning and peals of thunder were followed by a hailshower of unusual force, lumps of ice of irregular shape, $\frac{4}{10}$ to $\frac{5}{10}$ of an inch in diameter, fell in large quantities and with dangerous force; at $11^h\,50^m$ the barometer read 29·604 inches: the shower lasted about 5 minutes, and there fell 0·521 inch of hail and rain." Previous to this storm there was a terrific thunderstorm at $7^h\,30^m$ A.M. to $8^h\,40^m$ A.M., frequent flashes of forked lightning, with loud and long peals of thunder; no very great change in barometer readings. On the two following days thunder was heard, with much rain in showers of short duration.

Steps are about to be taken for mounting a Robinson's anemometer, in order to record the velocity as well as the direction of the wind.

Radcliffe Observatory, Oxford.—Very little change has been made during the past year either in the meteorological observations of the Observatory or in the instruments. Amongst the few changes of instruments may be mentioned the substitution of a vacuum thermometer by Negretti and Zambra, for determining the effects of solar radiation, in the place of the instrument formerly in use, the latter having been blown down and broken during a violent gale. Comparisons are still carried on between the temperatures of the air near the surface of the ground and at a height of 105 feet; and the results seem to show that the difference is very small at any season of the year.

The rain is measured by four gauges, of which one is placed on the ground, and the others at heights respectively of 22, 24, and 112 feet. A comparison has also been recently instituted between the quantity of ozone near the surface of the ground (as determined by Dr. Schönbein's test-papers) and at the top of the tower; and as yet no certain difference has been detected. In connexion with ozone it may be mentioned that, in the volume of the 'Radcliffe Observations' recently published, namely that for the year 1863, a Table is given containing the mean results for ten years as determined at this Observatory; and the general deductions agree well with those given by Dr. T. Bæckel in 'Les Mondes' for Dec. 21, 1865, vol. ix. p. 692.

The same vigorous discussion of the observations, involving a great amount of computing-labour, has been kept up as in former years.

Liverpool Observatory.—During the past year, the barometer and wet- and dry-bulb thermometers have been read at 8^h and 9^h A.M., and at 1^h, 3^h, and 9^h P.M. daily. Maximum and minimum thermometers have been read daily at 9^h A.M. The sheets containing the records of Osler's anemometer and pluviometer, Robinson's hemispherical cups, and King's barograph are all preserved for future reference.

The horizontal motion of the air, the direction of the wind, and the rainfall, together with the pressure of the atmosphere, corrected for temperature and reduced to the level of the sea, have been tabulated from the sheets for each hour of the day throughout the year.

The new Observatory now being erected at Bidston, Birkenhead, will be ready for the reception of the meteorological instruments in the course of a few months. Registering thermometers, placed in the grounds of the new Observatory, have been read daily during the past eighteen months, with the view of determining the difference of temperature between the two stations.

Royal Observatory, Edinburgh.—The meteorological labours of the Royal Observatery, Edinburgh, are nearly, though not quite, confined to the province of supervision and computation; but these are extensive, as the bidiurnal observations at fifty-five of the well-tended stations of the Meteorological Society of Scotland are sent there to be prepared for appearance in the Registrar-General for Scotland's Monthly and Quarterly Reports.

Towards this end, the monthly means are taken from the bidiurnal observations, instrumental corrections applied, moisture-coefficients computed by Glaisher's very admirable tables, and, finally, means of the whole country prepared for each month; which means are again discussed with the similar results for former years, and the distinguishing features of the passing weather pointed out, either as affecting the whole country similarly, or parts of it variously.

2ndly. The weekly observations of the deep-soil thermometers, with their bulbs at various depths (from 3 inches to 25 feet) in the rock of the Observatory hill, are still being carried on, and have been continued uninterruptedly from the year 1837.

3rdly. A small meteorological journal is carried on, for the sole purpose of forming a useful and, as it is often found, an explanatory accompaniment to the going of the astronomical clocks during periods of cloudy weather but when the error of the clocks is required to be known closely, for the purpose of public time-signals.

4thly. A special meteorological inquiry has been undertaken by the astronomer privately, on his own resources, in the course of the last year, resulting observationally in a meteorological journal having been kept daily and often hourly for a period of four months at the Great Pyramid in Egypt, and the temperatures of the interior of the Pyramid and of wells in the neighbourhood having been frequently observed. The object of these proceedings was to test by modern observation the theory assigning to the Great Pyramid in ancient times an intended adjustment of its temperature to a grand and useful natural unit; and the idea is so far borne out, that, after elimination of abnormal effects, the observed mean either exceeds or falls below the theoretical quantity according as different values are employed either for the decrease of temperature with height in the air, or the reduction of four months to the mean of twelve.

The agreement is, at all events, so near as to require modern science to look very carefully to the sufficiency of the usual methods of determining mean temperatures; and it is expected that the whole of the observations will be given to the public in Professor Piazzi Smyth's forthcoming work on 'Measures at the Great Pyramid in the year 1865 A.D.'

Wrottesley Observatory.—No alteration has been made in the observations taken at this Observatory. The anemometer is one of Osler's, and is on the same principle of registration as that in use at Liverpool.

Midland Institute, Birmingham. — The observations in meteorology at this Institute consist chiefly in the pressure of the atmosphere and registration of the wind. The barometer is a standard by Newman, and is read regularly at 9^h A.M. each day. The anemometer in use is a very excellent instrument made and presented by Mr. Osler, the results of which are registered exactly in the same manner as at Liverpool Observatory.

Wisbeach.—The usual daily meteorological observations have been continued at this station with great regularity throughout the year, and in addition to which the records of an Osler's anemometer have been kept up without intermission. From a statement of storms and gales received from Dr. Miller it appears that large pressures of the wind were experienced on thirteen days during the year 1865, the largest registered being that of 24 lbs. on the square foot on the 22nd of March.

Nottingham, Highfield House Observatory.—During the past twelve months the usual observations have been carried on, and the instruments have all been transferred from Beaston to Highfield House, a work, however, which has been somewhat retarded by the occupation of Mr. Lowe as Local Secretary to the British Association.

The important series of ozone experiments have also been continued, and the Rev. Mr. Redford of Silloth, who has been taking observations with the ozone tests, reports very highly upon their indications.

Osborne.—In addition to the usual daily observations taken at this station with great regularity and accuracy, an Osler's Anemometer is attached, and Mr. Mann has prepared a statement of the Gales and Storms which have occurred during the year, from which it appears that there were four heavy storms and nine lighter storms or gales experienced at this place. He then goes on to say that "Changing the above pressures into their relative velocities we obtain a current for the year of about 69,000 miles, or from four to five times the circumference of the earth, taken over our parallel of latitude.

"Having, from a rough calculation, estimated that the heat generated by the stoppage of the velocity of air would, for each mile of velocity it is reduced, raise the temperature of the mass of air that is being checked in its velocity some 26° Fahrenheit for each mile of velocity lost, if this heat was retained as heat in its own mass, I expected to have been able to trace a rise of temperature after a storm; but, on looking over the preceding observations, I find that the contrary, or a fall of temperature, is the general result."

When we consider the enormous number of cubic miles (a cubic mile weighs about five millions of tons) of air in motion in a great storm, and which must in its gradual reduction of velocity be generating heat to a large amount, although diffused over a vast area, it would not perhaps be a useless enquiry to endeavour, to discover what becomes of this heat, which surely has some effect on the mass of air which, by its cessation of motion, had given rise to it, either in altering the temperature of the mass of air simply in its vapour-bearing powers, or in producing electricity to charge or overcharge it.

The force we have rolling over us in a great storm is equal to the momentum of one continuous and uninterrupted stratum of the heaviest railway locomotive-engines, placed side by side, and driven at their utmost speed of sixty or eighty miles an hour. The momentum of a single heavy locomotive-engine passing in its full speed never fails to strike with awe the traveller waiting on the platform near its course; and when, as we may imagine in a great storm, the whole surface of a country is entirely and continuously enveloped for hours together with a force equal in each unit of surface to that of the passing locomotive, this force cannot, after doing its work in transposing the masses of air, different in temperature and in other qualities, over the earth, but be productive of some gigantic force or change, in its reduction to a state of comparative rest.

CAPE OF GOOD HOPE ROYAL OBSERVATORY.—The results from observations made at this Observatory from the 1st of January, 1842, to December 31st, 1862, have been recently published, and with these attached an interesting notice of La Caille's observations made in 1751–52. This valuable document includes a graphic description of the meteorological phenomena of Table Valley.

CAPE OF GOOD HOPE METEOROLOGICAL STATIONS.—The meteorological returns furnished by the colonial observers are undergoing reduction and arrangement, and it is expected that the results will shortly be published.

At the several stations spread over the colony there is—

One standard barometer.
One maximum and one minimum thermometer.
One pair of dry- and wet-bulb thermometers.
One rain-gauge.

At four stations Robinson's anemometers have been placed, and to several outlying stations rain-gauges alone have been sent.

SOUTH AUSTRALIA.—It is gratifying to find that in this extensive district of the Australian continent meteorological stations are being judiciously planted under the direction of Charles Todd, Esq., F.R.A.S. That gentleman, in his annual report on meteorological observations for 1863 (which has just been received), has the following remarks on the distribution and the scope of the several stations under his direction:—

"In presenting the following report on the meteorology of 1863, I am glad to think that, owing to increased care and experience of the different observers, the results are more reliable than in previous years. Observations were made at the following stations:— Adelaide, Kapunda, Mount Barker, Strathalbyn, Port Robe (Guichen Bay), and Mount Gambier. Self-registering thermometers were supplied to the Mount Barker station at the end of 1862, so that the thermometrical results for 1863 are more complete than in previous years. The rainfall is given for the following places, besides those just mentioned, which include nearly the whole of the agricultural and more thickly settled portions of the Colony, viz., Port Augusta, Mount Remarkable, Bungaree, Clare (telegraph office), Kooringa, Anlaby, Hamilton, Gawler (telegraph office), Walkerville, Brookside, Mount Lofty, Cox's Creek, Glenelg, O'Halloran Hill, Willunga (telegraph office), Montura, and Penola (telegraph office). For the pluvial returns from many of the foregoing places I am indebted to the kind co-operation of several gentlemen, who have, now for some years, cordially aided my efforts to obtain a more correct knowledge of the climatic characteristics of our adopted home than hitherto obtained. The results published in the following tables* will show what fallacious conclusions might be arrived at concerning the climate, were the observations of only one locality taken into account; the collection and publication, therefore, in one official document, of the quantity of rain, as well as the variations in other important meteorological elements over an extensive area, cannot fail to be of much practical value."

"The observations were taken daily at 9^h A.M. and 6^h P.M., these being, as before stated, the most convenient hours for the officers employed in the telegraph departments."

At the present time several instruments are being compared for Mr. Todd, and will shortly be forwarded to him.

METEOROLOGICAL DEPARTMENT OF THE BOARD OF TRADE.— Upon the death of the late Admiral FitzRoy a correspondence took place between the Board of Trade and the Royal Society with respect to the Meteorological Department of the Board of Trade. The result of that correspondence was the appointment of a Committee, consisting of the following gentlemen, viz.:—

Francis Galton, Esq., F.R.S., General Secretary of the British Association for the Advancement of Science: nominated by the President and Council of the Royal Society;

Staff-Commander Evans, R.N., F.R.S., Chief Naval Assistant to the Hydrographer of the Admiralty: by the Admiralty;

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* It is intended that abstracts from the more important of the results of these observations shall soon appear in these pages.—EDITOR.

T. H. Farrer, Esq., one of the Secretaries to the Board of Trade: by the Board of Trade;

To consider and report upon the following questions:—

1. What are the data, especially as regards meteorological observations at sea, already collected by, and now existing in, the Meteorological Department of the Board of Trade?
2. Whether any and what steps should be taken for arranging, tabulating, publishing, or otherwise making use of such data?
3. Whether it is desirable to continue meteorological observations at sea, and, if so, to what extent, and in what manner?
4. Assuming that the system of weather telegraphy is to be continued, can the mode of carrying it on and publishing the results be improved?
5. What staff will be necessary for the above purpose?

Upon commencing their labours the Committee found it necessary to enter at some length into the history of the Meteorological Department, and into its original as compared with its present functions. These subjects were fully investigated, and full statements of the proceedings of the Committee and the conclusions at which they arrived have been embodied in a voluminous report. The principal conclusions at which they have arrived are:—

1. That the meteorological observations at sea, already existing in the department, as well as those to be taken hereafter, should be discussed on a better plan.
2. That it is desirable to continue meteorological observations at sea.
3. That endeavours should be made to improve the storm warnings, to define the principles on which they are issued, and to test those principles by accurate observations. Above all, that steps should be taken for establishing a full, constant, and accurate system of observing changes of weather in the British isles. For that purpose it is recommended that the following six stations should be adopted and equipped:—

Falmouth.—Polytechnic Institution, lat. 50° 9′.
Kew.—Observatory of the British Association, lat. 51° 28′.
Stonyhurst.—The College, which has already a magnetical and meteorological observatory, lat. 53° 0′.
Armagh.—Observatory, lat. 54° 21′.
Glasgow.—University and observatory, lat. 55° 51′.
Aberdeen.—University, lat. 57° 9′.

The Committee finally recommend (if the above recommendations be adopted) that not more than three years should elapse without further inquiry into the manner in which the work is progressing; and in conclusion they pass a well-merited tribute to the zeal and perseverance of the late Admiral FitzRoy, in establishing a system of storm warnings, which (whatever be its shortcomings) is already highly prized by the seafaring class.

BALLOON ASCENTS.—In the Report of last year it was stated that Mr. Glaisher had brought his balloon experiments to a close, but on looking over some of the results it was evident that *the law of the decrease of temperature was different at different times of the day*, and at one ascent, made at about sunset, no difference of temperature was observed for 2000 feet from the earth. This fact suggested the probability that after sunset the temperature might even increase with increase of elevation, at least within the limit of height, and if so, such facts might have important bearings, not only on the theory of heat, but also on the theory of astronomical refraction. Hence arose the desire of nocturnal ascents.

To ascend at night it was necessary to have the means of reading the several instruments with facility, and this at last he was able to do by means of a well-constructed Davy miner's lamp. In October last, and again in December, he made two ascents, leaving the earth one hour and a half after sunset, and the results have justified the amount of trouble. In the first ascent, when the sky was cloudless, the temperature increased with increase of elevation. During the second ascent, when the sky was overcast, there was a small decrease of temperature as the height increased. A third ascent was made on May 29, leaving the earth one hour and a half before sunset, descending to 440 feet above the sea-level, but within 100 feet of the earth at the time of sunset, and then making a second ascent and descending one hour and a half after sunset. In the first of these ascents, on the last day, the temperature declined from 58° to 29½° at 6300 feet high, and in the second it also declined; but at 6300 feet the air was 5° warmer than it was at the same height before sunset. The results derived from these nocturnal observations deserve repetition and extension.

RAINFALL INVESTIGATIONS.—Mr. Symons has steadily persevered in his original purpose, the collection of all obtainable records of the rainfall in the British isles; the result being that returns, more or less complete, for nearly two centuries have been obtained at a few places, and from one or more of over 2000 different places, that some 1400 gauges are now regularly observed every morning, and that there are observers in every county of England, Wales, Scotland, and Ireland, excepting the Irish counties of Leitrim and Louth.

A copious index to the observations already collected has been compiled, printed at the expense of the British Association, and extensively circulated by Mr. Symons, with an urgent request for additions and corrections*. Great efforts have also been made to gather the records of rainfall kept by persons now dead, and which records have passed into other hands—a step almost invariably followed by their destruction. Many have been rescued from this fate by Mr. Symons, many still lie hidden in boxes of old papers and in private diaries; and all who know of any such will be doing good service by hunting them up and favouring Mr. Symons with either the originals or copies.

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* This index is accompanied by an outline sketch of the progress of rainfall investigations from A.D. 1677 to 1865.

The date to which each measurement of rain is to be entered (and which therefore involves the termination of the rain month) having been referred to the observers to ascertain the general practice, it was found that the majority were in favour of 9 A.M. and placing the amount then measured against the day preceding that on which it was measured. This regulation met Mr. Glaisher's approval and has also received the support of the Council of the Scottish Meteorological Society, who have passed a minute instructing their observers to adopt it. By these means it is hoped that very shortly the practice will be uniform throughout the United Kingdom.

The experiments already referred to in the 'Proceedings' of this Society are steadily continued and it is hoped before very long will be sufficiently ample to justify their being thoroughly discussed with the double object of ascertaining, if possible, 1st, the correction due to every variation in the height of the gauge above the ground; 2nd, the correction due to every variation in the size of the gauge. Some remarks having been made as to the amount of rain which, after passing into the gauges, escapes again by evaporation, so that for example if ·75 in. of rain falls, ·60 in. only would be measured; experiments have been commenced to test the maximum effect in black gauges without any inside can or bottle, and placed in the full rays of the sun, as compared with gauges thoroughly protected, all of them being left untouched save once a month. Experiments are also in progress as to the amount collected by funnels of different materials—glass, stoneware, ebonite, and metal. The results, it is hoped, will in due course be laid before the Society.

The examination of gauges *in situ* has been steadily proceeded with, but is in a measure prevented by the necessity of personal attendance to much of the correspondence incidental to so large a staff of observers as Mr. Symons has now established, and the general correspondence necessarily involved.

Weekly Meteorological Returns from large Towns.—In the Report of last year it was stated that daily observations were taken at Greenwich, Liverpool, Manchester, Birmingham, Leeds, and Bristol, and that the weekly results deduced by Mr. Glaisher were forwarded to the Registrar-General in London, and also that a copy was sent to the Registrar-General of Scotland, for insertion in the weekly returns. Since then, however, Sheffield and Newcastle-on-Tyne have been added to the list.

The following is a tabular statement of the present strength of the Society:—

	Fellows.			Totals.
	Life.	Ordinary.	Honorary.	
1864, June 15	54	236	10	300
Since Elected............	...	53		53
Since Compounded ...	+5	− 5		0
Deceased	−2	− 6		− 8
Retired	...	−16		−16
1866, June 20	57	262	10	329

The Society has to regret the death of several of its Fellows.

The deceased Fellows are—

Charles Biggs, Esq., who was elected into the Society on January 21, 1863.

William Corbett Burder, Esq., F.R.A.S., elected November 23, 1852.

John Lee, Esq., LL.D., F.R.S., F.R.A.S., who was one of the founders of this Society.

R. C. Vachell, Esq., M.D., elected November 16, 1859.

William Corbett Burder was born at Stroud, Gloucestershire, October 30, 1822. His father was the Rev. John Burder, M.A., who survives him, and his grandfather was the Rev. George Burder, the author of 'Village Sermons.' After serving five years of apprenticeship to an architect in Bristol, he left that profession, and, removing to London, studied architectural engraving under Mr. J. H. Le Keux. His success in this pursuit is shown by the engagement which Mr. Le Keux afterwards made with him for his services, as well as by the published portion of an unfinished work entitled 'Architectural Antiquities of Bristol,' the illustrations of which he both drew and engraved.

Early in 1852 disease of the lungs, of which there were slight indications in the previous summer, manifested itself by an attack of hæmoptysis, followed by other serious symptoms, from which he gradually rallied, though he never entirely regained his previous health. Under these circumstances he gave up engraving as too laborious and turned his attention to landscape-painting, applying himself with all his natural energy to the theory and practice of that art.

As a meteorologist he was widely known from his long connexion with Mr. Glaisher's corps of observers, and by the notices which he frequently sent to the 'Times' on matters of meteorological interest. He also published a few years since a little volume, 'The Meteorology of Clifton,' containing the condensed results of ten years' observations at that station. A severely accurate and conscientious observer himself, he instinctively detected the want of these qualities in others, and was always displeased when he found that a scientific statement had been coloured to serve a purpose, or a phenomenon recorded with a show of precision beyond what the circumstances permitted. At the root of this feeling was doubtless the intense love of truth which distinguished him through life, and was indeed the dominant principle in his character. To the same cause may be traced the antipathy which he entertained to the whole race of weather-prophets, a class of persons whom he disliked the more, as they tended to bring meteorology itself into disrepute amongst the half-informed.

In the observation of occasional phenomena, such as thunder-storms, snow-storms, and gales, he had taken from boyhood an enthusiastic interest, and several years ago, before the organization of the present telegraphic system, he prepared and submitted to the late Admiral FitzRoy a carefully considered scheme for the simultaneous observation of gales, with a view to tracing out their courses and laws.

In astronomy Mr. Burder found a source of genuine pleasure, and was ingenious in the construction of instruments. He devised a portable equatorial, of which he published an account in 'Recreative Science,' and he also constructed a clock, the accurate performance of which was very satisfactory.

For the last two years of his life increasing weakness confined him almost entirely to his room, and during this period his mechanical ingenuity showed itself in a great variety of contrivances adapted to meet his special wants. One of these was a mirror so placed as to reflect into his room the image of a vane erected on the roof of the house. Another was a ventilating apparatus, constructed so as to convey a constant supply of fresh external air, brought up to the temperature of the apartment by passing through a certain length of tube, and discharged at a point vertically over his face as he lay in bed. His condition of chest rendering him acutely sensitive both to cold and to impurity of air, he set great value on this invention, and was led into an extensive correspondence with persons whose attention had been attracted by his description of it in the 'Times.'

The deprivations and sufferings which, in spite of all his clever devices, were inseparable from a lingering illness were borne not merely with resignation, but with a spirit of contentment and cheerfulness which won the admiration of all who knew him, and doubtless contributed very much to prolong his life.

A rather sudden accession of unfavourable symptoms occurred about six weeks before his death, and from this time no prospect remained of anything beyond a temporary rally. Yet even now he retained an interest in his former pursuits, and his love of nature never failed him. One evening, during this time, being told of a beautiful sunset, he requested a mirror to be placed so as to reflect it, and by this means was enabled to see it as he lay in bed. His sufferings were at intervals severe, but his mental faculties remained unclouded, and his last moments were eminently tranquil and happy. He died on the 16th of October, 1865, at the age of 43, devotedly beloved by those who stood nearest to him, and sincerely lamented by a wide circle of friends.

Some features of Mr. Burder's character have been already touched upon. The promptness and energy with which he set about his various undertakings were remarkable; not less the perseverance with which he carried on labours requiring prolonged and steady application. The unbroken series of observations which, from the beginning of the year 1853, he supplied for the use of the Registrar-General may be taken as a proof of this. He was not without confidence in his own judgment in matters which he had studied deeply, but with this was associated a humble respect for the opinions of those whose attainments in any department of knowledge gave them a title to deference. Sociable without frivolity, and well informed without a trace of pedantry, of a cheerful disposition, a ready humour and transparent honesty of purpose, he was a genial companion as he was a sincere and trusty friend, and his memory will long be cherished with the affection which such qualities command.

Dr. **Lee** was one of the founders of this Society in 1850, and filled the offices of Treasurer, Member of Council, Vice-President, and President successively.

He was the eldest son of the late John Fiott, Esq., merchant of London, a descendant of the old Burgundian house, Fiott of Dijon, by Harriott, daughter of William Lee, Esq., of Totteridge Park, Herts, and grand-daughter of Sir William Lee, who was Lord Chief Justice of England in 1754.

He was born on the 28th of April, 1783, and educated at St. John's College, Cambridge, where he was fifth wrangler in 1806, and took his degree of LL.D. in 1816. He was duly elected Fellow and Travelling Bachelor of his college, in which capacity he travelled extensively in the east and on the continent, where he succeeded in amassing a very valuable collection of antiquities, which it was always the study of his after life to increase, as the collections at Hartwell will bear testimony. He assumed the name of Lee in lieu of his patronymic by royal licence in 1815, in compliance with the will of his maternal uncle William Lee Antonie, of Colworth House, Bedfordshire, devisee of Sir George Lee, Bart. On the death of Sir George Lee without issue in 1827 the whole of the family property devolved upon the subject of this memoir.

Dr. Lee afterwards became a Member of Doctors' Commons, and filled the offices of Treasurer and Librarian to the College; but he never entered actively into the practice of his profession. In 1864 he was made a Q.C. by Lord Chancellor Westbury, an honour which it is said afforded him great satisfaction. He was one of the oldest Magistrates in the county of Bucks, having been appointed on the commission of the peace in 1819, and his name stood first on the roll of High Sheriffs for 1867. He was Lord of the Manors of Hartwell, Stone, and Bishopstone, and patron of two livings.

Dr. Lee was a Fellow of the Royal Society, and was also a Fellow and for two years the President of the Royal Astronomical Society. He was also a Member of the Geological, the Geographical, the British Archæological, the Syro-Egyptian, the Asiatic, the Chronological, the Numismatic, and other learned Societies. It will be remembered that when the Members of the Archæological Association, the Lincoln Diocesan Architectural Society, and the Northamptonshire Architectural Society met on Bosworth Field in 1862, Dr. Lee was chairman of that Congress. Among his services to science not the least is the erection at Hartwell of one of the best private observatories in the kingdom, where for a series of years competent observers have, at Dr. Lee's cost, been engaged in astronomical and meteorological observations. The livings of Hartwell and Stone were placed some years ago by Dr. Lee at the disposal of the Astronomical Society.

Dr. Lee's benevolence as a landlord and a master are well known in the county of Bucks, and his munificent donation of 1000 guineas to the Bucks County Infirmary, which was opened mainly through his exertion in 1833, will long be remembered.

The late doctor, besides being descended from the famous Chief Justice Lee, was not a little proud of claiming descent also from Hampden, whose figure with those of Harcourt and Lee are in the windows of the Chapel erected at Hartwell by Sir William Lee in 1756. Hartwell was the retreat of Louis XVIII., 1807–14, and has been in the possession of the Lees since 1617.

He died at Hartwell House on the 25th of February, 1866, in the 83rd year of his age.

The following Papers have been read at the Ordinary Meetings during the Session 1865–66:—

1. "On extended Series of Meteorological Observations in Russia." By Lieut. Rikatcheff, I.R.N. Translated from the Report of the Director of the Hydrographical Department of Russia.
2. "On the First Publication of the Results of the extended series of Meteorological Observations in Russia." By Lieut. Rikatcheff, I.R.N.
3. "Temperature at Greenwich and at Newport." By John C. Bloxam, Esq., M.R.C.S., F.M.S.
4. "Translation of some Remarks by Professor Wolf on Professor Lamont's Paper on the Ten-year Period of the Magnetic Variation and of the Solar Spots." By W. T. Lynn, Esq., B.A.
5. "Description of a New Anemometer for Self-registering the Pressure, Velocity, and Direction of the Wind." By C. O. F. Cator, Esq., M.A., F.M.S.

6. "The November Showers of Meteors in 1865." By James Glaisher, Esq., F.R.S., Secretary.
7. "Heights and Velocities of the November Meteors, 1865.—Meteors simultaneously observed at Greenwich Observatory and at Hawkhurst." By A. S. Herschel, Esq., B.A.
8. "The November Shower of Meteors." By C. G. Prideaux, Esq., F.R.A.S.
9. "On the Daily Weather Diagram for 1865, and the Comparisons of the Curves of each of the Elements delineated thereon with each other, and with the Weekly Imperial Average Prices of Wheat and with the Mortality." By C. O. F. Cator, Esq., M.A., F.M.S.
10. "On the Progress of Rainfall Investigations, and on Fluctuation in the Annual Fall of Rain." By G. J. Symons, Esq., F.M.S.
11. "Researches on the Distribution of Temperature on the surface of Switzerland during the Winter 1863–64." By Professor E. Plantamour. Translated from the Paper read before la Société Helvétique des Sciences Naturelles at its Meeting in Zurich, August 23, 1864. By James Glaisher, Esq., F.R.S., Secretary.
12. "Analysis of the Winds." By John C. Bloxam, Esq., M.R.C.S., F.M.S.
13. "On Rain-Gauges." By R. Strachan, Esq., F.M.S.
14. "On the Barometrical Pressure, Temperature, and Rainfall of Birmingham, from observations taken from 1853 to 1864." By David Smith, Esq., F.R.A.S., F.M.S.
15. "Results of Meteorological Observations taken at Mentone (Western Bay), South of France, during the winters 1863–64, 1864–65, 1865–66." By D. A. Freeman, Esq., F.M.S.
16. "On the Climate of the colony of Natal." By Dr. Mann, F.R.A.S., F.M.S.
17. "On the best means of measuring Terrestrial Radiation." By Fenwick W. Stow, Esq., M.A., F.M.S.
18. "On the Prevalence of Rain in the North Atlantic, South Atlantic, and a part of the North Pacific Oceans." By Frederick Gaster, Esq., F.M.S.

The Report having been read, the following Resolutions were carried unanimously:—

Proposed by E. W. Brayley, Esq., F.R.S., F.G.S.
Seconded by F. W. Doggett, Esq.

That the Report, which has just been read, be received and adopted; and that it be printed and circulated among the Fellows of the Society.

Proposed by W. Camps, Esq., M.D., F.S.S.
Seconded by L. P. Casella, Esq., F.R.A.S., F.R.G.S.

That the cordial and best thanks of the Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

The President appointed W. Camps, Esq., M.D., and W. Hering, Esq., M.D., as Scrutineers; a ballot was then taken, and the following list of Members, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the eighteenth Session, 1866–67:—

THE OFFICERS AND COUNCIL

OF

THE METEOROLOGICAL SOCIETY,

ELECTED 20TH OF JUNE, 1866.

President.

C. BROOKE, ESQ., M.A., F.R.S., &c.

Vice-Presidents.

N. BEARDMORE, ESQ., C.E., F.R.A.S.
W. P. DYMOND, ESQ.
T. SOPWITH, ESQ., M.A., F.R.S.
C. V. WALKER, ESQ., F.R.S., F.R.A.S.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square*, W.

Trustees.

ANTONIO BRADY, ESQ., F.G.S.
S. W. SILVER, ESQ.

Secretaries.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., *Dartmouth Place, Blackheath*, S.E.
J. W. TRIPE, ESQ., M.D., 7 *King's Place, Commercial Road*, E.

Foreign Secretary.

LIEUT.-COL. ALEX. STRANGE, F.R.S., F.R.A.S., 41 *Brompton Crescent*, S.W.

Council.

J. C. BLOXAM, Esq., M.R.C.S.
E. W. BRAYLEY, Esq., F.R.S., F.G.S.
A. BREWIN, Esq., F.R.A.S.
Sir C. BRIGHT, M.P., F.R.A.S.
C. O. F. CATOR, ESQ., M.A.
A. J. CUMING, ESQ., A.K.C.
F. W. DOGGETT, Esq.
H. S. EATON, ESQ., M.A.
G. H. SIMMONDS, Esq.
G. J. SYMONS, Esq.
G. V. VERNON, Esq., F.R.A.S.
S. C. WHITBREAD, Esq., F.R.S.

The following Resolution was then put to the Meeting and carried unanimously:—

Proposed by W. Hering, Esq., M.D.
Seconded by E. W. Brayley, Esq., F.R.S., F.G.S.

That the thanks of the Society be given to the Officers for their services during the Session that has now closed.

NOTICE.

Session 1866–67.

The Meetings will be held on the Third Wednesday in the months,
at 25 Great George Street, Westminster, S.W.,
by the kind permission of
The Council of the Institution of Civil Engineers.

Ordinary Meetings at 8 p.m.

1866.	November	21	1867.	March	20
1867.	January	16	„	April	17
„	February	20	„	June	19

The Annual General Meeting will be held after the Ordinary Meeting on June 19.

Council Meetings.

1866.	October	17	1867.	March	20
„	November	21	„	April	17
1867.	January	16	„	June	19
„	February	20			

ERRATA.

'Proceedings,' No. 25.

Page 169, heading of letter, *for* Sheatley *read* Streatley.
„ 169, bottom of letter, *for* John Slaten *read* John Slatter.
„ 170, 1st line, *for* Rev. J. Slaten *read* Rev. J. Slatter.

Account of the Treasurer for the year 1865.

Receipts.

						£	s.	d.	£	s.	d.
1865.											
Jan.	1.	To Balance of last year							73	6	10
		Do. of Charter Fund				92	11	6			
Apr.	19.	Four Subscriptions to Charter Fund				3	11	0			
						96	2	6			
Aug.	29.	One do. do.				5	0	0	101	2	6
April	19.	Dividend on £800 New 3 per Cents.				11	14	0			
Oct.	24.	Do. do. do.				11	16	0			
						23	10	0			
April	13.	Composition of Right Hon. E. P. Bouverie				10	0	0			
Dec.	31.	Subscriptions for 1864	6	0	0						
		Do. 1865	197	3	0						
		Do. 1866	4	0	0	207	3	0			
		Sales of Proceedings, &c.				8	14	6			
Dec.	31.	Total Receipts							249	7	6
									£423	16	10

1866.					
Jan.	1.	To Balance in hand (including Charter Fund)	£151	19	4

CHARTER FUND.

Receipts.

			£	s.	d.	£	s.	d.
1866.								
Jan.	1.	To Balance of Charter Fund				101	2	6
Jan.	31.	Twenty Subscriptions Charter Fund	65	15	0			
Feb.	28.	Six do. do.	7	4	0			
						72	19	0
						£174	1	6

1866.					
Feb.	28.	To Balance of Charter Fund	£38	8	6

HENRY PERIGAL, Jun., *Treasurer.*

JOHN BROWNING, *Auditor.*

Account of the Treasurer for the year 1865.

Expenditure.

1865.		£	s.	d.	£.	s.	d.
Jan. 15.	By Proceedings, No. 16	28	15	0			
Feb. 15.	Do. No. 17	24	18	0			
Mar. 16.	Do. No. 18	14	0	2			
April 19.	Do. No. 19	17	3	10			
June 21.	Do. No. 20	34	7	4			
Nov. 15.	Do. No. 21	38	0	6			
		157	4	10			
Dec. 31.	Registrar-General's Reports	7	6	6			
	Printing				164	11	4
	Stationery £5 19*s.* 6*d.* Postage Stamps £8 7*s.* 2*d.*	14	6	8			
	Secretary's Petty Expenses	5	4	0			
	Librarian's do.	2	8	3			
					21	18	11
	Attendance, and Refreshments after Meetings	9	9	9			
	Cavendish Society's Publications, presented to Civil Engineers' Institution	10	8	0			
					19	17	9
	Editor of the Proceedings	52	10	0			
	Commission on Subscriptions	10	7	0			
					62	17	0
	Total PAYMENTS				269	5	0
	Book-Case				2	12	6
	Balance of Charter Fund	101	2	6			
	Do. in hand	50	16	10			
					151	19	4
					£423	16	10

CHARTER FUND.

Expenditure.

1866.		£	s.	d.	£	s.	d.
Jan. 28.	By Expenses of obtaining Charter	123	15	6			
Feb. 21.	Printing on account of Charter	11	17	6			
					135	13	0
Feb. 28.	Balance				38	8	6
					£174	1	6

Treasurer's Account for the first half of the year 1866.

Receipts.

1866.		£	s.	d.	£	s.	d.	£	s.	d.
Jan. 1.	To Balance of last year				50	16	10			
	Do. Charter Fund				38	8	6			
	BALANCE							89	5	4
June 30.	Subscriptions for 1865	9	0	0						
	Do. for 1866	73	4	0						
					182	4	0			
	Life Subscription of—									
Jan. 2.	Lieut. E. H. Verney, R.N.	10	0	0						
Apr. 3.	T. H. Morgan, Esq.	10	0	0						
					20	0	0			
	SUBSCRIPTIONS				202	4	0			
Apr. 18.	Dividend on £800 New 3 per Cents				11	16	0			
June 30.	Sale of Proceedings, &c.				9	7	10			
	Total RECEIPTS							223	7	10
								£312	13	2

1866.		£	s.	d.
June 30.	To Balance (including Charter Fund)	£180	13	10

H. PERIGAL, JUN., *Treasurer.*

JOHN BROWNING, *Auditor.*

Treasurer's Account for the first half of the year 1866.

Expenditure.

1866.		£	s.	d.	£	s.	d.
Jan. 16.	By Proceedings, No. 22	17	11	0			
Feb. 21.	Do. No. 23	22	2	6			
Mar. 21.	Do. No. 24	21	1	6			
Apr. 18.	Do. No. 25	16	15	9			
	PROCEEDINGS, four Nos.	77	10	9			
June 30.	Registrar-General's Reports, two Quarters	3	3	0			
	PRINTING				80	13	9
	Stationery	5	10	6			
	Postage Stamps	7	7	7			
	Secretary and Editor's Petty Expenses	3	5	6			
	EXPENSES				16	3	7
	Assistant to Editor of Proceedings	26	0	0			
	Collector's Commission	9	2	0			
	SALARIES				35	2	0
	Total PAYMENTS				131	19	4
	Surplus of last year	50	16	10			
	Do. first half of this year	91	8	6			
	Together	142	5	4			
	Surplus of Charter Fund	38	8	6			
	BALANCE				180	13	10
					£312	13	2

The November Meteors, 1866.

To the Editor.

Sir,—As the attention of astronomers to the "Great November Shower" is aroused by a prediction of Professor Newton, that the November meteors will return in the present year, and as the prediction is advanced upon grounds so purely astronomical that it is not in the least degree likely that it will be contradicted by the event, I scarcely need to apologize to your readers, if you accord me valuable space in your Journal, for offering for their consideration a short plan of the chief points of interest to observe, or upon which the attention of observers may be most profitably bestowed in the "Great November Shower."

The main body of the meteors is expected to visit the western shores of the Atlantic Ocean towards sunrise on the morning of the 14th of November. In the absence of the moon darkness may be expected to add a distinctive character to the display, both in the number and brilliancy of the meteors, and in the peculiar features of leaving streaks, &c., which render them unique. Should it, however, take place a few hours earlier than the predicted time, the maximum, instead of being visible in America, will be visible in Europe. It may be noticed that for two years past, the 13th and not the 14th of November has been the principal date of the occurrence. A strict watch for the maximum intensity of the shower is accordingly recommended to be kept in England on both of the mornings of the 13th and 14th of November, by counting the meteors continuously, or at intervals, on each morning from midnight until sunrise. Several observers might combine together, dividing the points of the compass equally between them, one person registering for all, so that the possibility of counting a meteor twice would be avoided. The number of observers should be noted, and the amount of cloud, or clear sky; and it will be distinctly understood that the November meteors are never seen before midnight, and that they are only visible from midnight until day-break*.

The planet Venus, seen in the evening near its greatest brightness, is a suitable object for comparison with the bright meteors. Smaller meteors may be compared with the magnitudes of the fixed stars, and larger meteors with the diameter of the moon.

The duration of a meteor's flight, or of its streak, may be noted very nearly to the sixth part of a second, by repeating letters of the alphabet immediately after the disappearance of the meteor. In the case of the most enduring streaks, it is important to observe through the prisms of a direct-vision spectroscope, if the yellow line of burning sodium, or if the light of any other substance in combustion, as the alkaline earths, is very brilliant in the spectrum of the streak.

---

* The constellation Leo will not appear above the horizon till after 11^{h} P.M. on the 12th; and Regulus, the brightest star in the constellation, will be on the meridian on the morning of the 13th, at about 6^{h} 25^{m}.

During the hour from 1 to 2 o'clock on each morning, a stricter watch is recommended to be kept, with the view of obtaining as many simultaneous observations of meteors as possible at distant places. The following particulars of every meteor seen should then be recorded; viz. the instant of appearance to the nearest second of Greenwich time; the brightness, colour, and duration of the meteor, of its streak; and its direction, as from one star, or from one part of one constellation to another, or the place of its first appearance, and of the point of its disappearance by an altazimuth instrument, or otherwise. Any peculiarity of its appearance, as if it changes its light or colour, or if it bursts, should be recorded. More observations will also be made in the intervals from 1 to 2 o'clock if the labour is divided with an assistant, who would register the time (by a good seconds watch), and the other particulars of the observations in writing.

For some minutes after the bursting of very large meteors any noise should be attentively listened for, noting the intervening time. Auroras and distant lightning should also be looked for.

The paths of the meteors prolonged *backwards* cross each other at a point about the centre of the "sickle" in the constellation *Leo*, from which point the meteors accordingly appear to emanate. To fix the exact position of the point, and to map as many of the meteors as possible during the hour on each morning from one to two o'clock, the Luminous Meteor Committee's Star-maps are distributed to experienced observers, who have already availed themselves to useful purpose of their skill in this kind of observations.

By means of the maps, and by attending to these directions, the meteoric shower, it is expected, will be so well observed in England, as to afford useful materials for discussion, and for comparison with materials obtained in other places.

I am, Sir,
Your obedient Servant,
A. S. HERSCHEL.

Collingwood, Hawkhurst,
October 9th, 1866.

Note.—At various periods in the middle ages great displays of meteors, commonly called fire-balls or shooting-stars, have been observed shortly before the middle of November. On Tuesday morning, November 12th, 1799, for several hours there was a very remarkable display seen by Humboldt at Cumana, in South America; the same was seen at St. Fernando d'Apura, 300 miles S.W. of Cumana; at Mario, more than 200 miles further in the same direction; and near the equator, 700 miles south of Cumana, this display was very fine; there were thousands of luminous meteors seen during a space of four hours.

In England, clouds and rain were generally prevalent, yet in some localities many meteors were observed.

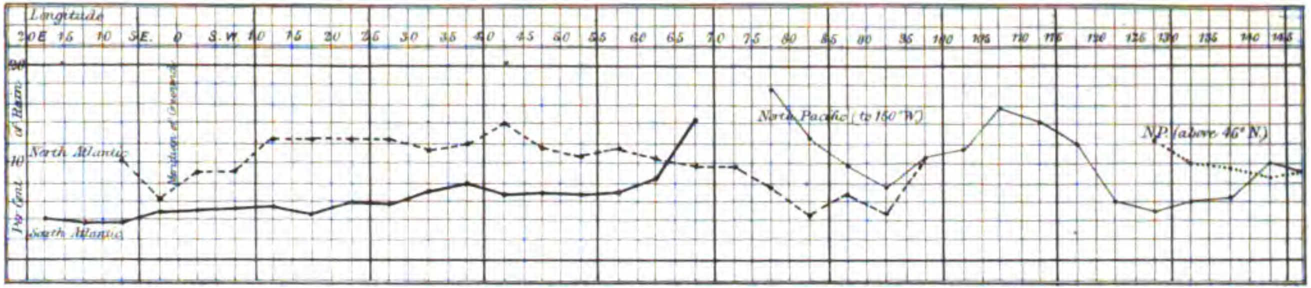
On the morning of November 13, 1832, meteors were seen in unusual numbers throughout Europe; on the morning of June 13, 1833, a more remarkable shower was seen from places situated between Cuba and Greenland; the display began after midnight. The morning was cloudy in England.

On the morning of November 13, 1865, a very large number of meteors were observed at the Royal Observatory, Greenwich (see the 'Proceedings' for 1866, Jan. 17).

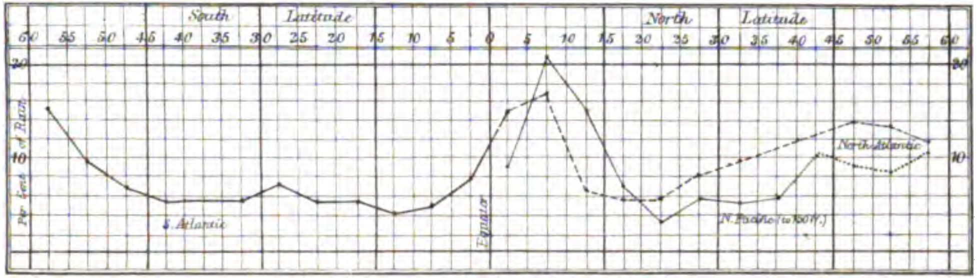
Mr. Newton, discussing the recorded star-shower between the years 902 and 1833, deduces 33¼ years for the length of one cycle, and observes, that during a period of two or three years, at the end of each cycle we may expect a shower. The periodicity thus indicated has been found to apply to meteor-displays at other parts of the year. The November shower, however, has retained its superiority, and the display this year is expected to exceed that of last year, and to equal the displays of 1799 and 1833.—Editor.

Proc. Met. Soc. Plate III

PER-CENTAGE OF RAIN FOR EACH 5° OF LONG: FROM 20° E. TO 150° W. (LAT: 0° TO 60°)

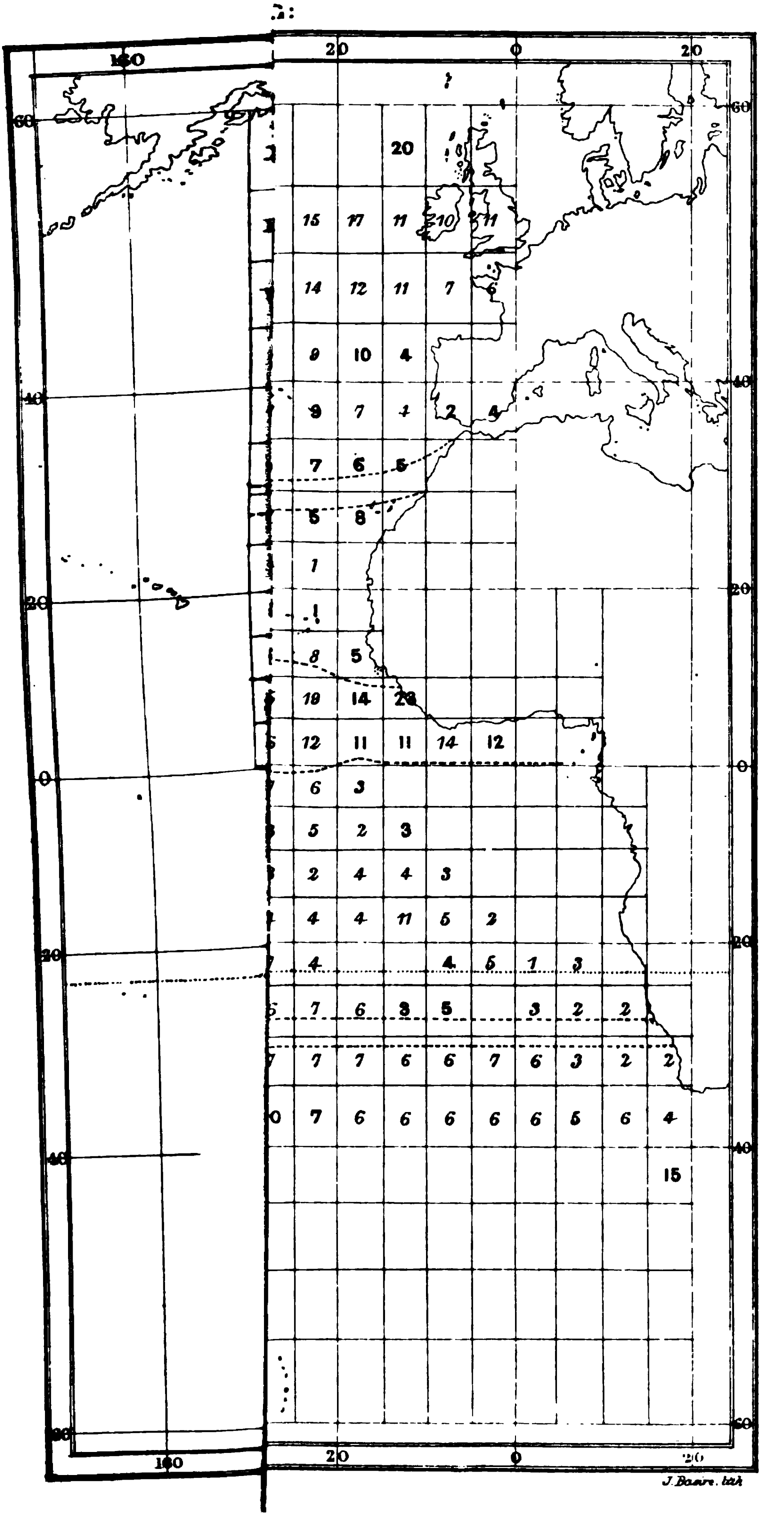


PER-CENTAGE OF RAIN IN EACH ZONE OF 5° OF LAT: FROM EQUATOR TO LAT: 60°.



J. Basire lith.

Proc. Met. Soc. Plate IV.



J. Basire, lith.

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OF

THE METEOROLOGICAL SOCIETY,

Session 1866–67,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., at 7 p.m.

1866.	November	21	1867.	March	
1867.	January	16	„	April	
„	February	20	„	June	

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PROCEEDINGS

OF

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EDITED BY
JAMES GLAISHER, Esq., F.R.S., Secretary.

1866, NOVEMBER 21.

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OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. III. 1866, NOVEMBER 21. [No. 27.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Henry Samuel Tabor, Esq., 16 Lansdowne Road, Notting Hill;
Dr. Barker, 14 Eaton Place, Brighton, Sussex;

were balloted for and duly elected Fellows of the Society.

The names of Four Candidates for admission into the Society were read.

CXXV. *Comparison of Standard Barometers at different Observatories in Europe.* By Lieut. Rikatcheff, I.R.N.

After a residence of several months in England, making myself acquainted with the several magnetical and meteorological instruments and their general use, and with the method of treating observations in that country*, I proposed visiting some other principal observatories in Europe. I spoke about my plan to my friend James Glaisher, Esq., F.R.S. &c., who suggested that I should take with me my standard barometer and a thermometer, and, having compared those instruments with the standards of Greenwich Observatory, compare them also with the standards of all the observatories I should visit, then return to Greenwich to see if my instruments had changed or not; and this I have done.

---

* The greater part of this time was spent at Greenwich Observatory; and I have no words to express how thankful I am to the Astronomer Royal and to James Glaisher, Esq., F.R.S. &c., the Director of the Magnetical and Meteorological Department of the Royal Observatory, for their kindness, hospitality, and assistance in giving me all the information I needed, as well as facilities for visiting other observatories.

My barometer is of the construction which is recommended by the Meteorological Society of England. It has a fixed brass scale, the lower end of which is terminated by an ivory cone, to which the level of the mercury (which is in a cistern of glass) can be adjusted by means of a screw at the bottom of the cistern. The divisions on the scale are made in English inches to 0·05 inch. By means of a vernier, the readings can be taken to 0·002 inch, and with a little experience they are easily taken to 0·001 inch.

The barometer was prepared with all care by Mr. Browning (111 Minories), and is numbered 44. Mr. Glaisher had the kindness to carefully examine the barometer before I received it from Mr. Browning. He tested the divisions on the scale independently of comparison; and when the comparisons were made, they confirmed the correctness of the scale—the index-error nearly compensating the effect of capillarity, which is about 0·006 inch, the inner diameter of the tube being about 0·42 inch, and the mercury having been boiled in it. During the comparison of my barometer with the standards of different observatories, I had occasion to notice the exactness of the thermometer attached to my barometer*; and at Upsala I tested it with Dr. Rubinson, in comparison with a thermometer (No. 8) of which the index-error was well known: this thermometer was suspended close to my barometer; and from about forty readings taken during three days, at different hours of the day, I found that both thermometers (after applying the corrections for index-error to No. 8) read alike, to the first decimal place of Fahrenheit's scale.

Before leaving England I suspended my barometer in the room in which the standard barometer of Greenwich Observatory is placed. This barometer was made by Newman, about 1840. The scale is of brass, and is affixed to a brass rod sliding in the support and terminated in its lower part by an ivory cone: the rod with the scale can be raised or lowered by means of a slow-motion screw; and by this motion the point of the cone, which is the zero of the scale, can be adjusted to touch the surface of the mercury in the cistern. The vernier subdivides the scale-divisions to 0·002 inch. The mercury has been boiled in its tube, whose diameter is =0·565 inch. This barometer was found to coincide with the flint-glass standard of the Royal Society, for which the authority can be seen in the Philosophical Transactions for 1838, part 2, p. 431, "Description of a New Barometer," by Francis Baily, Esq., Vice-President and Treasurer R.S.

---

* The only place where I found a considerable difference between the readings of the attached thermometer of my barometer, and the attached thermometer of another barometer, was at the Paris observatory.

The Greenwich barometer has been used as standard for about one thousand other standard barometers distributed all over the world.

At Greenwich, as well as at other observatories, attention was paid to bringing the compared barometers to vertical positions by means of a plumb-line.

During six weeks the comparison of my barometer with the standard barometer of Greenwich was made, by all the Observers of the Magnetical Department and by myself.

Reducing all these readings to 32°, I found the index-error from ninety-five observations:—barometer No. 44 (R.)—barometer Greenwich =+0·0008 inch. When all the comparisons made by myself were collected together, and those made by other observers also collected, I found the index-error of barometer No. 44—barometer Greenwich, as deduced from seventy-three observations by myself =+0·0008 inch, and the same value deduced from twenty-two observations by other observers =+0·0011 inch. Both results being so close the one to the other, my personal error in comparison must be insensible.

Collecting separately all comparisons made when the readings were decreasing, increasing, or stationary, the respective numbers were +0·0005 inch, +0·0009 inch, +0·0009 inch; and therefore increasing or decreasing readings of the barometer have little or no influence on the result of comparison.

On the 6th day of April, 1866, I took the last reading of both barometers at Greenwich, and then packed my barometer in tow in a box prepared by Mr. Browning. The Astronomer Royal suggested the fixing a bag full of tow at either end of the box. I am much obliged to the Astronomer Royal for those bags, which at once were prepared at the Observatory, and which I am sure have been very beneficial in providing for the due safety of my instrument in its many journeys.

On the 12th of April my barometer was suspended close to the standard of the Paris Observatory. This standard is of Fortin's construction, and was made by Fortin himself. The scale is of brass, with divisions in millimètres and parts of a millimètre. By means of a vernier the readings are taken to 0·02 of a millimètre.

The readings were taken by M. Rayet and myself. I reduced the readings of each barometer to 32° Fahrenheit, and then converted the readings of the standard of the Paris Observatory into English inches, and took the differences of those readings. I used the tables of the Smithsonian Institution, by Arnold Guyot, LL.D.; and the same plan for reduction was adopted for the comparison of all other barometers. The mean difference deduced from thirty-six readings was,

Barometer No. 44—barometer of Paris Observatory
$= -0{\cdot}0049$ inches.

The same difference, if deduced from seventeen observations by M. Rayet, would be $= -0{\cdot}0049$ in., and deduced from nineteen observations by myself would be $-0{\cdot}0050$ in.

The thermometer attached to the barometer of the Paris Observatory was found to be about 1°·5 Fahrenheit higher than the thermometer attached to my barometer; and therefore, if the comparison were made independently of different readings of thermometers, the value of

Barometer No. 44—barometer of Paris Observatory would be
$= -0{\cdot}0090$ inch.

On the 22nd of May I suspended my barometer close to the standard of the Brussels Observatory. This standard was made by Ernest, and is numbered No. 120; it is of Fortin's construction, and the diameter of its tube is nearly 0·4 inch.

Several readings were taken by Ernest Quetelet, an assistant at the Observatory, and others by myself. The result found was,

Barometer No. 44—barometer of Brussels Obs. $= +0{\cdot}0104$ inch.
This gives

Barometer of Paris Observatory—barometer of Brussels Observatory $= +0{\cdot}0194$ English inch $= +0{\cdot}49$ millimètre.

Some twenty years ago M. Delcros compared with his Fortin barometer the standards of the Paris and Brussels Observatories, and found,

Fortin Delcros—No. 120 d'Ernest at Brussels $= +0{\cdot}46$ millim.,
Bar. of the Paris Observatory—Fortin Delcros $= -0{\cdot}013$ millim.;
and therefore

Barometer of Paris Observatory—barometer of Brussels Observatory = +0·45 millim.

This is a good illustration of the constancy of the index-error of a well-made barometer.

The correction 0·46 millim. has always been applied to the barometric readings taken at Brussels Observatory since the determimination by M. Delcros. If this correction be applied to all readings before the reduction of the observations, we have,

Barometer No. 44—barometer Brussels = −0·0076 inch.

From the 24th of May my barometer was for six days suspended close to the standard barometer of Utrecht Meteorological Observatory. The standard is a siphon barometer made by M. Becker of Arnheim. The scale is of brass, with divisions in millimètres to 0·5 millim., and a vernier subdivides the divisions to 0·02 millim. The diameters of the shorter and longer arms of the tube are about 0·45 inch, and the effect of capillarity is avoided. The specific gravity of the mercury in the barometer was determined by M. Becker to be 13·586.

The readings are taken by means of two microscopes—one affixed to the scale, with its optical axis corresponding to the zero of the scale, and moved with the scale by means of a screw working in a fixed nut; the other is moved on the upper part of the scale, and has a vernier of which the index corresponds to the optical axis of the microscope. The barometers of the greater number of the meteorological stations in Holland have been compared with the standard barometer of Utrecht, and the corrections which were found from these comparisons have been applied to the readings of those barometers before being published in the volumes of meteorological observations for Holland.

The readings of the barometer at the Observatory and of my barometer were taken, simultaneously, by M. Krecke (the Director of the Meteorological Observatory) and by myself. M. Krecke was kind enough to take some readings of both barometers. The result of twenty-nine observations was,

Barometer No. 44—barometer of Utrecht Observatory = −0·0214 inch.

On the 3rd of June my barometer was suspended in the room in which the barometer of Munich Observatory is placed: this barometer has a fixed wooden scale, with contracted divisions, for compensating the error produced by the changes of level of the mercury in the cistern. Professor Lamont has himself investigated all corrections to be applied to this barometer.

During four days the readings of both instruments were taken simultaneously, M. Lamont having the kindness to take the readings of his barometer whilst I read mine; and some readings were also taken by the assistant of the Observatory. The readings of the barometer of Munich Observatory have been reduced to 0° Cent., using the Table given by M. Lamont in his 'Annalen der Königlichen Sternwarte bei München,' Band iii. (der vollständigen Sammlung, Band xviii.), 1849, this Table being computed for barometers with wooden scales, which are supposed to be invariable for changes of temperature.

There is always a doubt, however, as to the effect of temperature and humidity upon a wooden scale; and therefore the index-error of barometers of such construction as that at Munich Observatory is more liable to change than the index-error of standard barometers with brass scales. At the time I made the comparison between my barometer and that of Munich Observatory, I found the result of ten readings to be,

Barometer No. 44 − barometer at Munich Observatory
= −0·0135 inch.

On the 13th of June my barometer was suspended close to the standard siphon barometer of Professor Dove at Berlin. This barometer is very nearly of the same construction as that of Utrecht Observatory, and is used as standard for the greater number of the meteorological stations in Germany. The readings of the siphon barometer were taken by Professor Dove, and of my barometer by myself; and the result of the comparison gives

Barometer No. 44 − barometer Dove = −0·013 inch.

On the 18th of June my barometer was suspended close to the barometer of the Central Physical Observatory of St. Petersburg. The barometer of the Observatory is a siphon, and the diameter of its tube is about 0·25 inch; the scale is of brass, divided into Russian half-lines. Some readings for comparison were taken by two observers of the Observatory, and others by myself. The mean result found was,

Barometer No. 44 − barometer of the Central Observatory
= +0·005 inch.

From the 25th to the 30th of June my barometer was suspended close to the standard barometer of the Imperial Academy of Sciences at St. Petersburg.

Nineteen readings were taken by the optician of the Academy of Sciences and by myself. Reducing the observations, I assumed the temperature of both barometers to be the same, using that which was indicated by the thermometer attached to my barometer, being told that the thermometer attached to the barometer of the Academy was not to be trusted. I found the result of the comparison to be,

Barometer No. 44—barometer of Imperial Academy of Sciences at St. Petersburg = −0·0070 inch.

The standard barometer of the Academy of Sciences was investigated for index-error by Professor Lentz, and was found to be too low by 0·07 half-line, or by 0·0035 inch. If this correction be applied to all observations taken by this instrument, the difference between the published observations of the barometer of the Imperial Academy of Sciences and observations as taken by my barometer, will be,

Barometer No. 44—barometer of Imperial Academy of St. Petersburg = −0·0105 inch.

On the 4th of July I suspended my barometer close to the standard of Pulkova Observatory, and I took (with M. Smysloff, formerly Astronomer of Pulkova Observatory, now the Director of the Vilna Observatory) two readings, and the result found was,

Barometer No. 44—barometer of Pulkova = +0·014 inch.

On the 12th of July my barometer was suspended close to the standard of the Royal Academy of Sciences at Stockholm. Professor Edlund kindly read his own barometer whilst I read mine, and then we interchanged the instruments and took another reading. From three observations, between the 12th and 14th, the mean result was,

Barometer No. 44—barometer of the Royal Academy at Stockholm = −0·0095 inch.

Acceding to the wishes of Professor Svanberg, the Director of the Observatory of Upsala, and of Dr. Rubinson, the Director of the Meteorological Department of that Observatory, after returning from Upsala, I made at Stockholm, with Professor Edlund, a second comparison, obtaining from eight readings a mean difference of −0·0092 in.; and the mean from all comparisons is therefore,

Barometer No. 44—barometer of the Royal Academy of Sciences at Stockholm = −0·0098 inch.

The barometer of the Royal Academy is a standard of Fortin's construction, made by Pistor and Martins at Berlin, and is numbered 579; its readings are taken by means of a microscope. Its scale is of brass, and divided into Paris lines. It was improved under the superintendence of Professor Edlund, who prepared the mercury himself, the specific gravity of which he found to be 13·596.

The mercury was boiled in the tube throughout. The scale was compared with the national standard measure, and a correction of +0·02 Paris line was deduced from this comparison. This correction is included in the number I have given above for the difference of readings of my barometer and the barometer of Stockholm.

The attached thermometers of both barometers proved to be very nearly alike.

On the 15th of July my barometer was suspended at the Observatory of Upsala, from 3 to 4 feet distant from the standard barometer. The readings of both instruments were taken simultaneously—those of the barometer of the Observatory by Dr. Rubinson, and of my barometer by myself; and after each of those readings we interchanged the instruments and took the readings again.

From all of those readings, thirty-two in number, I found the following result:—

Barometer No. 44—barometer of Upsala Observatory
= +0·0007 inch.

The attached thermometers of both barometers were tested by comparing their readings with those of two old thermometers, No. 7 and No. 8, whose index-errors had been annually determined, suspended close to one of the barometers. This comparison proved that both attached thermometers are free from error.

The standard barometer of Upsala Observatory is of the same construction as that of the Royal Academy of Sciences at Stockholm; it was made by Pistor and Martins of Berlin, and is numbered No. 578.

On the 27th and 28th of July my barometer was suspended in the same room with the standard barometer of the Agricultural Academy of Copenhagen. This barometer was made by Mr. Younger, and is not numbered; it is of Fortin's construction, and has a diameter of tube of about 0·4 inch. The scale is of brass, with divisions in Paris lines. The readings of the barometers were made by M. de la Cour, the Assistant Professor of the Agricultural Academy, and by myself. Reducing those readings, I found:

Barometer No. 44—barometer of the Agricultural Academy at
Copenhagen = −0·0186 inch.

Returning to England, I suspended my barometer on the 3rd of August in its former position, close to the standard of Greenwich Observatory. The result from sixty-nine observations, taken during three weeks, by all observers of the Magnetical and Meteorological Department and by myself, was,

Barometer No. 44—barometer of the Royal Observatory
= +0·0006 inch,

showing that my barometer had not changed during my travels.

During the time I was making the second comparison of my barometer with the standard of the Royal Observatory, a standard barometer by Negretti and Zambra, No. 648, for Christiania, was undergoing comparison with the standard of the Royal Observatory; and I availed myself of this opportunity to compare my barometer with the standard of the Christiania Observatory. This standard is very nearly of the same construction as my own; but it has a double scale—one divided into English inches, and another into millimètres; I took the readings of both scales, and calculated the index-error of barometer No. 648 as deduced from readings taken on the scale of English inches, and also as deduced from readings taken on the scale divided into millimètres. In the first case I found,

Barometer No. 44—barometer of Christiania Observatory
= +0·0117 inch;

and in the second case, for the same value, I found +0·0094 inch; and taking the mean of these values, we have,

Barometer No. 44—barometer of Christiania Observatory
= +0·0105 inch.

For every comparison I calculated the mean error of one reading, and the probable error of the final result by the general rule of the theory of probabilities.

For Pulkova and Berlin, where the number of observations was only two, I give, instead of the probable error of result, the difference between the results of the two readings.

The following Table represents the results of all comparisons, giving differences of reading of my barometer—other barometers, independently of errors of attached thermometers, and independently also of corrections, which were found in several places, and which are applied to the barometer readings before they are published; but I give those corrections in a separate column. In the same Table is also given the number of observations from which each result is deduced, and the above-mentioned probable error of each final result.

Number of observations.	Instruments under comparison.	The final result of comparison.			Mean error of one observation.	Probable error of final result.	Correction applied at present at several places.
		in.	millim.	Paris line.			in.
95	Barometer No. 44—barometer of Greenwich Observatory *before* the comparison of other barometers	+0·0008	+0·020	+0·009	±0·0021	±0·0002	
36	Barometer No. 44—barometer of Paris Observatory	−0·0090	−0·229	−0·101	±0·0015	±0·0001	
7	Barometer No. 44—barometer of Brussels Observatory..	+0·0104	+0·264	+0·117	±0·0028	±0·0009	+0·0181
29	Barometer No. 44—barometer of Utrecht Observatory..	−0·0214	−0·544	−0·241	±0·0047	±0·0007	
10	Barometer No. 44—barometer of Munich Observatory ..	−0·0135	−0·351	−0·155	±0·0026	±0·0007	
2	Barometer No. 44—barometer of Prof. Dove at Berlin	−0·013	−0·33	−0·146	......	0·002	
12	Barometer No. 44—barometer of Central Physical Observatory at St. Petersburg	+0·005	+0·13	+0·06	±0·003	±0·001	
2	Barometer No. 44—barometer at Pulkova Observatory..	+0·014	−0·36	+0·158	......	0·002	
19	Barometer No. 44—barometer of Imperial Academy of Sciences at St. Petersburg.....................	−0·0070	−0·178	−0·079	±0·0021	±0·0006	+0·0035
14	Barometer No. 44—barometer of Royal Academy of Sciences at Stockholm..........................	−0·0057	−0·145	−0·066	±0·0027	±0·0007	+0·0036
32	Barometer No. 44—barometer of Upsala Observatory ..	+0·0007	+0·018	+0·008	±0·0012	±0·0003	
	Barometer No. 44—barometer of Agricultural Academy at Copenhagen	−0·0186	−0·468	−0·209	±0·0029	±0·0010	
	Barometer No. 44—barometer of Christiania Observatory	+0·0105	+0·266	+0·118	±0·0032	±0·0010	
69	Barometer No. 44—barometer of Greenwich Observatory *after* the comparison of other barometers	+0·0006	+0·016	+0·007	±0·0026	±0·0003	

The probable error was calculated by the formula $f=\frac{2}{3}\frac{\sqrt{\Sigma e^2}}{n}$, where f is the probable error of final result, e the probable error of each reading, the sign Σ shows that the sum of all values of e^2 must be taken, and n is the number of observations.

1866. July	COPENHAGEN. Agricultural College. Standard Barometer. Readings.	Attached therm. Celsius.	Barometer No. 44. Readings.	Attached therm. Fahrenheit.
26.	334·98	19°·4	29·741	71°·4
	334·97	„	29·744	„
27.	334·47	18·5	29·690	64·0
	334·49	„	29·693	„
28.	334·54	18·0	29·704	70·2
	334·54	„	29·701	„
29.	334·34	16·7	29·689	67·8
	334·34	„	29·694	„

The barometer-readings at different observatories are generally published with three decimals, if in English inches, or with two if in Russian half lines, millimètres, or Paris lines. The difference between standard barometers, as we see in the Table, is in some cases 0·02 English inch. I will not endeavour to solve the delicate question which of these barometers is right. For making comparable the barometrical observations as they are published at different places, it is easy to find from the preceding Table what correction should be applied to the other barometers, if one be adopted as standard.

In a short time I hope to give the results of comparison of my thermometer with several standard thermometers.

In closing my article, I beg permission to express my best thanks to the Astronomer Royal and Director of the Greenwich Observatory, G. B. Airy, Esq., F.R.S., &c.; the Director of the Magnetical and Meteorological Department of the Observatory, J. Glaisher, Esq., F.R.S., &c.; the Senator and Director of the Paris Observatory, M. Le Verrier, and his assistant, M. Rayet; the Director of the Brussels Observatory, M. Quetelet, and his son, E. Quetelet; the Director of the Utrecht Observatory, M. Krecke; the Chief of the Meteorological Department in Holland, Professor Buys-Ballot; the Director of Munich Observatory, Professor Lamont; the Chief of the Meteorological Department in Prussia, Professor Dove; the Director of the Central Physical Observatory at St. Petersburg, Professor Kaëmtz; the Director of the Physical Cabinet of the Imperial Academy of Sciences in St. Petersburg, Professor Jacobi; the Director of Pulkova Observatory, O. Struve; the Director of Vilna Observatory, Captain Smysloff; the Chief of the Meteorological Department in Sweden, Professor Edlund; the Director of Upsala Observatory, Professor

Svanberg; the Director of the Meteorological Department of Upsala Observatory, Dr. Rubinson; the Director of the Copenhagen Observatory, Professor d'Arrest; the Assistant Professor of the Agricultural Academy in Copenhagen, M. De la Cour—for their kindness and most effective assistance, in enabling me to make the necessary comparison of barometers, and deduce the correction applicable to each.

CXXVI. *Comparison of Thermometers at different Observatories in Europe.* By Lieut. RIKATCHEFF, I.R.N.

IN my paper on the intercomparison of standard barometers of several European observatories, I mentioned that during my progress through those observatories I made an intercomparison of their standard thermometers. I used for this purpose two thermometers, made with all care by Mr. Browning, marked No. 116 and No. 117. The readings of these thermometers were kindly compared on the 26th of February, 1866, by J. Glaisher, Esq., F.R.S. &c., with those of his standard thermometer. The readings of Mr. Glaisher's standard were found to be sensibly coincident, some twenty-five years ago, with those of the original thermometers constructed by the Rev. R. Sheepshanks during his preparations for the construction of the National Standard for Length. (The high authority of Sheepshanks's thermometers can be seen in the paper "On the Construction of Standard Thermometers," by the Rev. R. Sheepshanks.)

Mr. Glaisher's standard has since then been tested on many occasions; and it was found that, after a few well-determined changes of small extent during the first two or three years, the thermometer remained sensibly unchangeable.

Before I left England I was kindly supplied by Balfour Stewart, Esq., F.R.S., the Superintendent of the Kew Observatory, with a standard thermometer, divided in Reaumur's scale, and marked No. 371. Its error was determined in December 1865 by Mr. Balfour Stewart, and was found

at freezing-point to be —0°·05 Reaumur,
at boiling-point ...... —0°·05.

On the 24th and 26th of February, 1866, I compared my standard thermometer with Mr. Glaisher's, and from a great number of readings, taken when both thermometers were placed in water of different temperatures, I found that Mr. Glaisher's standard—my standard was,

between 0° and 4° Reaumur	....	−0°·02 Reaumur.
„ 5 „ 9 „	....	−0·02 „
„ 10 „ 14 „	....	−0·02 „
„ 15 „ 19 „	....	−0·03 „
„ 20 „ 24 „	....	−0·03 „
„ 25 „ 29 „	....	+0·03 „
„ 30 „ 35 „	....	+0·06 „
„ 35 „ 40 „	....	+0·19 „

These results confirm the steadiness of Mr. Glaisher's standard, and prove that my standard reads sensibly correct between 0° and +25° of Reaumur.

The readings of thermometers No. 116 and No. 117 being coincident with the readings of Mr. Glaisher's standard, I could trust that they were sensibly correct before my departure from England.

On the 16th of May, 1866, the readings of thermometers No. 116 and No. 117 were kindly compared by M. Rayet with those of a standard thermometer of the Paris Observatory, marked No. 86, with an arbitrary scale. The thermometers were placed successively into fine pounded ice, then into water of about +10°, and finally into water of about +30° Centigrade. The following Table gives the result of this comparison:—

	at 0° Cent.	at 10° Cent.	at 30° Cent.
The Paris thermometer—thermometer No. 116	0·00	0·00	+0·11
The Paris thermometer—thermometer No. 117	+0·03	−0·07	+0·09.

The Paris thermometer therefore is sensibly coincident with thermometers Nos. 116 and 117 at 0° and at 10°, and is about 0°·10 C. higher at +30° Centigrade.

On the 22nd of May the thermometers No. 116 and No. 117 were compared with two standards of the Brussels Observatory. The older standard thermometer of the Brussels Observatory was constructed by M. Bunton in 1836; it is divided into Centigrade degrees; and its boiling- and freezing-points were determined by M. Regnault in 1843, when he sent the thermometer to the Brussels Observatory. Its correction is found to be −0·°14 Cent.; and this correction has been applied to all observations. The other standard was constructed by M. Baudin in 1859: its zero was found a year ago to be correct. The thermometers were placed in water, which was kept well stirred during the time the readings were being taken.

The results of four readings at the temperature of about 13° Centigrade were the following:—

Bunton thermometer—thermometer No. 116 = +0°·04 Cent.
Bunton thermometer—thermometer No. 117 = +0·03 „
Baudin thermometer—thermometer No. 116 = +0·00 „
Baudin thermometer—thermometer No. 117 = —0·02 „

These results prove that the mean of readings of thermometers Baudin and Bunton give readings sensibly the same as the mean of readings of thermometers No. 116 and No. 117.

On the 30th of May I made the comparison of my thermometers with the standard thermometer (No. 322) of Utrecht Observatory, made at Kew some years ago. Its divisions are in Reaumur's scale.

The result of comparison at the temperature of about 18° Reaumur was the following:—

Thermometer No. 322—thermometer No. 116 = 0°·00 Fahr.
Thermometer No. 322—thermometer No. 117 = —0·07 „

Or the readings of the standard of Utrecht Observatory are sensibly the same as the mean of readings of No. 116 and No. 117.

On the 4th of June my thermometers were compared with four standard thermometers of Munich Observatory. The readings of those standards were kindly taken by Professor Lamont himself, whilst I read my thermometers. All thermometers were placed, first, into water, which was left for many hours in the same room. The mean of the corrected readings of the four standards of Munich Observatory was 15°·95 Cent. The mean of readings of No. 116 and No. 117, converted into Centigrade values, was 15°·97.

Then all these thermometers were placed into water, which was left all day in the underground room, where another set of readings was taken. The mean of the corrected readings of the four standards of Munich Observatory was 9°·35 Cent.; the mean of readings of No. 116 and No. 117, converted into Centigrade values, was 9°·38.

On the 14th of June comparison was made at Berlin of the thermometer No. 116 with the standard thermometer of Professor Dove, who had the kindness to read his thermometer himself, whilst I read thermometer No. 116. Both thermometers were placed in water which had remained many hours in the room where the comparison was made. The readings of both thermometers were coincident to 0°·05 (Fahr.). I left my thermometers in July at St. Petersburg. In August I was in England again, and made a second comparison of my standard thermometer No. 371 with Mr. Glaisher's standard, and I brought the thermometer No. 371 to St. Petersburg. On the 15th of September I made the comparison of thermometer No. 371 with thermometers No. 116 and No. 117. Taking into consideration the small corrections to be applied to the thermometer No. 371, as determined by the last comparison with Mr. Glaisher's standard, and the independent determination of the corrections to be applied to each of the thermometers at the freezing-point, I found the following corrections were required to be applied to the thermometers No. 116 and No. 117.

In Fahrenheit's Scale.	Amount of correction in Fahrenheit's Scale. For the Thermometers No. 116.	No. 117.
At 32°	0°·00	0°·00
51	−0·18	−0·23
55	−0·22	−0·25
61	−0·11	−0·13
72	−0·01	+0·01
85	+0·03	+0·07
100	+0·31	+0·16

Assuming that the corrections of thermometers No. 116 and No. 117 between the 26th of February and the 15th of September changed proportionally to the time, we shall have for those thermometers on the 16th of May the following Table of corrections in Fahrenheit's scale:—

In Fahrenheit's Scale.	Amount of correction in Fahrenheit's Scale. For the Thermometers No. 116.	No. 117.
At 32°	0°·00	0°·00
51	−0·10	−0·12
55	−0·12	−0·13
61	−0·06	−0·07
71	−0·01	+0·01
85	+0·02	+0·04
100	+0·17	+0·09

Applying these corrections to the readings of thermometers No. 116 and No. 117, taken at Paris on the 16th of May, we shall have the numbers reduced to Mr. Glaisher's standard; and from the Table given on p. 251, the following Table is deduced:—

	In Centigrade Scale,		
	at 0° Cent.	at 10° Cent.	at 30° Cent.
The Paris thermometer—Mr. Glaisher's thermometer (deduced from readings of thermometer No. 116)	0°·00	+0°·04	+0°·10
The Paris thermometer—Mr. Glaisher's thermometer (deduced from readings of thermometer No. 117)	+0·03	−0·02	+0·06
The mean from both results will be— The Paris thermometer—Mr. Glaisher's thermometer	+0·01	+0·01	+0·08

Discussing in the same way the comparisons made at Brussels, Utrecht, Munich, and Berlin, it is easy to see that the standards of all those places at the temperatures at which the comparisons were made, agree with Mr. Glaisher's standard thermometer and with standards constructed at Kew to 0°·1 Fahr.

CXXVII. *On the Percentage of Rainy Weather.*

By R. Strachan, F.M.S.

In the valuable paper by Mr. Gaster in the June Number of the 'Proceedings,' the percentage of rainy weather on the English coast appears as 11, and on the French coast as 6. Probably the mean (8½) may be safely taken as the average percentage duration of rain on the south-eastern portion of England. As this value is the result of grouping general observations of the weather of eight-hourly periods, without definite estimates of the actual duration of the rain, in hours, some of the periods classed as rainy may have been actually 7, 6, 5, or a less number of rainy hours; and consequently the percentages would generally be stated too high. It seems probable, however, that the frequent small durations of rain may have been omitted, so as to neutralize this possible error. Nevertheless I felt desirous of applying some sort of test; and the only means within my reach were some observations on the duration of rain made by myself in London, during thirty consecutive months, commencing with 1862. As the result which I have deduced from them seems to testify to the accuracy of the method pursued by Captain Maury in tabulation, and equally to that of Mr. Gaster's calculations, I beg to submit my figures to the Society.

During the thirty months alluded to, according to an estimate as carefully made as possible, rain fell at London during 1951 hours; so that, had the rain been continuous, it would have lasted eighty-two days nearly. The time of observation embraced 912 days; therefore the percentage prevalence of rain was

$$\frac{82 \times 100}{912} = 9.$$

This is evidently a sufficiently close agreement with the figures on Mr. Gaster's chart. I give below the monthly results of the observations on rain during these thirty months.

Months.	1862.			1863.			1864.		
	Inches.	Days.	Hours.	Inches.	Days.	Hours.	Inches.	Days.	Hours.
January	1·86	19	88	2·34	16	70	1·09	11	80
February ...	0·37	9	25	0·52	9	34	1·04	21	65
March	3·40	22	130	0·72	11	35	2·83	18	90
April	2·34	14	80	0·71	10	20	0·89	7	42
May	3·04	16	90	1·31	11	75	1·98	11	57
June	2·45	20	83	4·05	15	75	1·51	11	46
July	2·27	17	68	0·92	4	20	0·47	6	Not recorded.
August	2·45	12	72	1·77	17	40	1·29	9	
September ...	1·70	12	55	3·20	16	84	2·42	12	
October	3·23	21	94	1·58	18	72	1·06	11	
November ...	1·12	10	53	1·85	12	90	2·38	12	
December ...	1·44	17	66	1·32	9	52	0·51	8	

CXXVIII. *On an Improved Anemometer.*

By L. P. Casella, Esq., F.R.A.S.

That a familiar knowledge of the wind's currents, direction, and force is one of the wants of the day, will be readily conceded when we view the extent of individual effort to attain this end. Beside the amount of talent which has lately been directed to this subject, and the ready disposition, indeed anxiety, evinced by our own, and I may say, all other civilized governments to aid in this inquiry, it seems painful to observe the restricted nature of our appliances for this purpose.

For some years, therefore, my attention has been directed to the want of a good practical self-recording anemometer at a moderate cost. On the one hand we have the well-known though costly and excellent cup anemometer of the British Association at the Kew Observatory, costing £70, and on the other a smaller one on the cup principle, costing £4, and registering velocity only; lastly, we have Lind's simple non-registering arrangement, showing force by depressing and raising a column of water in a small U-tube; and although this latter has been ingeniously modified by Sir Snow Harris, it yet seems inconvenient in use, and is seldom adopted. Between these extremes I am not aware of any reliable instrument for measuring the course, velocity, and time of the various changes and movements of the wind. As all these results are obtainable from only one of these instruments, viz. the larger and most costly, it will readily be seen how great is the want of one of an intermediate description.

In speaking with Mr. Beckley, the ingenious engineer of the Kew Observatory, on this head, I was delighted to find not only that his views were in accordance with mine, but that he would readily aid me with his skill and great experience to overcome the difficulty. The first consideration then was, what we could do at a great reduction of cost, as well as of size and weight, and, I may add, of complexity; for, independently of other considerations, the mere mechanical difficulty of fixing the larger kind of anemometer has more than once required the personal guidance of some of our highest meteorological authorities, and that, too, at serious distances from the place of its construction. The result of our efforts I have now the pleasure of placing before you. The principle adopted is practically that of the force and die, the efficacy and durability of which is well known. The size is about one-third, and the weight one-fourth of that of its larger predecessor, the price being less than half, viz. £32. The mode of action is equally simplified: thus the cups, revolving in connexion with a chain of any required length, turn a pair of embossing rollers, through which, by means of a weight, they draw a narrow strip of paper, and impress it with figures which show the rate at which the wind has been travelling. One revolution of these rollers represents one hundred miles horizontal movement of wind. The direction is shown on the same slip by means of a small embossing arrow which is turned by the vane (their movements being identical); whilst a small hammer, moved by the clock, is made to fall on the arrow once in every hour or at shorter intervals, and thus impress it with the direction. Another important advantage obtained in using this anemometer is, that the paper need only be changed and observations taken once a week, or even at much longer intervals, as such strips are easily obtained of great length, say, fifty yards or more, and in use are made to unwind in the same way as a ribbon from a roller—the only other attention being that of daily winding-up the clock. With these advantages, it is confidently hoped that the movements of the wind may now soon be better known and discussed.

An instrument of this kind and cost can easily be placed, say, at least in each town in the kingdom; whilst its simple arrangement and durability renders now easy that which has so far been difficult, owing to the insufficiency of the smaller instruments, and the labour, cost, and uncertainty which has hitherto attended the fixing of the larger kind.

CXXIX. *Meteoric Shower of November* 13–14, 1866.

J. Glaisher, Esq., F.R.S., Royal Observatory, Greenwich.

In consequence of illness I was necessitated to view that part of the meteoric shower situated in the northern portion of the sky only. I directed my attention wholly to examine the spectra of the meteors, and the direction of their trains; in those seen I was unable to detect any special lines in the spectra indicative of the presence in the combustion of the body, or in the trains, of either alkaline salts or metals. The arrangements at the Observatory were entrusted to Mr. W. Nash, F.M.S., who has furnished the following account.

W. C. Nash, Esq., F.M.S., Greenwich.

At the Royal Observatory, Greenwich, arrangements were made with the several observers of the Magnetical and Meteorological Department for strictly observing the expected shower of luminous meteors on the morning of November 13; but the clouded state of the sky entirely precluded the possibility of making any observations. At night, however, the sky became clear, and by 11h P.M. there were assembled for continuous observation throughout the morning of the 14th the following observers:—W. C.

Nash, A. Harding, F. Trapaud, E. Jones, T. Wright, G. Farncomb, G. Stevenson, and H. Carpenter.

The efforts of the observers were chiefly devoted to the three following classes of observation, viz.:—

1. The determination of the number of meteors seen during the shower.
2. Obtaining good observations of paths &c., for suitable determination of the radiant-points.
3. Observations of the spectra of the meteors and trains.

For convenience, I propose to review the observations and their results in this order.

1. From 9^h P.M. to 11^h P.M. on the night of the 13th, in a clear sky, few meteors were seen; but these were marked in a high degree by brilliancy, long endurance, and great length of path: soon after 11^h P.M., however, they began to appear more rapidly, and two observers were at once placed in commanding positions to count the number of meteors which became apparent. After midnight, the greatly increased number of meteors rendered it necessary to increase the number of observers; so that before the time of maximum number the sky was divided between four observers, and yet, even with this force of observers, counting all meteors in their respective quadrants, and rendering account every five minutes, and sometimes oftener, to a recorder of observations, I believe that many passed unheeded and uncounted. Towards 2^h A.M. (near the close of the third hour of continuous counting) it was found that the numbers in all directions had so greatly fallen off, denoting that the maximum intensity of the shower was over, that I withdrew the assistants from this arduous duty, reserving them to count only for three intervals of five minutes each in each hour of the three succeeding hours. The numbers counted are embodied in the following Table, those for the hours antecedent to the commencement of regular counting having been derived from the continuous records of three observers, who were engaged in noting the paths of every meteor which appeared.

TABLE I. Showing the number of Meteors counted in five-minute periods in each Hour, from 1866, November 13^d 9^h P.M. to November 14^d 5^h A.M., at the Royal Observatory, Greenwich.

Hours of Observation. 1866, Nov. 13–14.	Number of Meteors counted in each five minutes.												Total Number per Hour.
	0^m–5^m	5^m–10^m	10^m–15^m	15^m–20^m	20^m–25^m	25^m–30^m	30^m–35^m	35^m–40^m	40^m–45^m	45^m–50^m	50^m–55^m	55^m–60^m	
9^h P.M. to 10^h P.M....	0		3		1		3		2		1		10
10^h P.M. to 11^h P.M....	3		1		0		0		6		5		15
11^h P.M. to midnight	12		20		23		33		42 (cloudy in north for five minutes.)		38 (cloudy in north.)		168
Midnight to 1^h A.M...	18 (Cloudy.)	15 (Very cloudy.)	17 (Cloudy.)	74 (Less cloudy.)	96 (Clear.)	151	182	293	348	231 (Cloudy.)	280	327	2032
1^h A.M. to 2^h A.M. ...	442 (Cloudy here and there.)	591	10^m–17^m 605 (seven minutes).	17^m–22^m 539	22^m–27^m 611	27^m–30^m 313 (three minutes).	470	399	307	171	264	148	4860
2^h A.M. to 3^h A.M. ...	......	......	......	......	......	......	......	64	83	61	......	......	Estimated. 995
3^h A.M. to 4^h A.M. ...	......	......	......	......	......	......	......	40	47	45	......	......	Estimated. 541
4^h A.M. to 5^h A.M. ...	......	......	......	......	......	......	......	......	......	10			Estimated. 165

Total Number from Nov. 13^d 9^h P.M. to Nov. 14^d 5^h A.M. 8786.

The number given in the preceding Table for total number during the eight hours' watch, namely 8786, is (as before stated) probably far less than the true amount; and, taking into consideration the fact of the prevalence of cloud during about forty-five minutes, and also the difficulty sometimes experienced by the observers in counting the meteors as quickly as they appeared, I think that the total number must have been at least equal to 10,000, and was probably in excess of that number.

From the numbers in the foregoing Table, averages per minute have been formed, in order to avoid unequal divisions of time; and these averages have been laid down in a curve (Plate VI.), which shows in a very marked degree the limitation of the shower to the two hours following midnight, and gives at a glance a more definite idea of the period of actual maximum activity of the shower than can be obtained from an inspection of the numbers themselves. The time of maximum would seem to have been about 1^h^ 20^m^ A.M. to 1^h^ 25^m^ A.M.; but this period is somewhat doubtful, owing to the intervention of clouds a few minutes earlier. During one minute, namely that from 1^h^ 4^m^ A.M. to 1^h^ 5^m^ A.M., with a clear sky, there were counted no fewer than 132 meteors; but the average for one minute from the five minutes' observations from 1^h^ A.M. to 1^h^ 5^m^ A.M. is not nearly so great as the average for one minute from the observations from 1^h^ 20^m^ A.M. to 1^h^ 25^m^ A.M. It must, however, be borne in mind that during four minutes out of the five in the former period the sky was partially cloudy, whilst in the latter period the sky was free from cloud.

I may here mention that during three periods, each five minutes in duration, at different parts of the shower, observations were made of the number which appeared in each minute; and as one of these periods happened near the time of maximum intensity, it may be interesting to exhibit the numbers counted in a tabular shape.

TABLE II. Number of Meteors counted per minute at three different periods between midnight and 2ʰ A.M.

Between what minutes.	Number of Meteors in each minute.	Remarks.
h m Midnight to 0 1 A.M.	5	Cloudy in the north.
h m 0 1 A.M. to 0 2 A.M.	5	
0 2 A.M. to 0 3 A.M.	4	Cloudy in all directions.
0 3 A.M. to 0 4 A.M.	2	
0 4 A.M. to 0 5 A.M.	2	
1 0 A.M. to 1 1 A.M.	37	Clouds here and there.
1 1 A.M. to 1 2 A.M.	77	
1 2 A.M. to 1 3 A.M.	96	
1 3 A.M. to 1 4 A.M.	100	
1 4 A.M. to 1 5 A.M.	132	Clear.
1 30 A.M. to 1 31 A.M.	76	Cloudless.
1 31 A.M. to 1 32 A.M.	84	
1 32 A.M. to 1 33 A.M.	96	
1 33 A.M. to 1 34 A.M.	111	
1 34 A.M. to 1 35 A.M.	101	

2. The observations of paths of meteors upon which good determinations of radiants could be based amount from all observers to about 200, of which at least two-thirds are conformable to Leo, and give, when projected on a chart, a mean radiant above γ Leonis, or right ascension 148° 50′, and declination north 24°. The determinations from all the observers' paths of this radiant are sensibly the same.

3. Many attempts were made to obtain definite information regarding the composition of the meteors by means of their spectra. The spectroscope (Herschel-Browning's) was directed to a prolific field, across which the meteors were constantly passing; and many spectra were seen, but in nowise could I perceive that they differed from the spectra of the surrounding stars. With the trains, also, I cannot lay claim to any greater success; an examination of them gave white streaks only in the spectroscope, similar to their appearance when viewed with the naked eye.

In conclusion, a few words may be devoted to the colours, sizes, &c. of the meteors; and I may remark generally that, during the great shower, a far greater proportion of very large meteors of all colours were seen than I remember to have ever before witnessed, but that after 2^h^ A.M., when the numbers decreased, blue meteors of no very unusual size were the prevalent kind. Little additional information upon these points can be obtained from the observer's notes, owing to the scantiness of the number of definite observations as compared with the total number of meteors which appeared.

W. T. Lynn, Esq., B.A., F.R.A.S., Greenwich.

This morning I commenced to observe the prophesied display of meteors about 2 o'clock mean time. I had arranged so to do from not expecting the principal shower until the rising of Leo; but, in fact, the grandest appearance had already taken place. My intention was to make my observations at the Royal Observatory, where I took my station on an exposed place on the leads near the east dome, whilst an assistant, Mr. Thomas Wright, computer in the astronomical department of the Observatory, stood inside the dome and recorded my observations by the aid of the sidereal clock, Earnshaw, placed there for astronomical purposes. I have reason to hope, therefore, that although the number of observations I have to report is but small, they may (at least the greater part of them) lay claim to a considerable degree of accuracy. I should remark that I made no attempt to count or determine the number of meteors which came into view whilst I was watching, but aimed solely at noting the times and places of a few of the more remarkable ones.

The first was a very remarkable one; it appeared at $2^h\ 13^m\ 35^s$ A.M. between Regulus and γ Leonis; almost at once separated into several fragments equal to stars of the 2nd and 3rd magnitudes (the light obscuring or rendering undistinguishable η Leonis), remained stationary for nearly 20^s, and then gradually disappeared. The colour was very brilliant. About 1 minute afterwards my attention was arrested by a splendid meteor (of which I forgot to record the exact time), leaving a brilliant streak, which appeared close to Mars and moved rapidly towards Procyon.

At $2^h\ 22^m\ 27^s$ A.M. a fine meteor appeared and remained visible for 3 seconds, but left no train. Its direction was nearly parallel to γ and β Ursæ Majoris, but somewhat nearer to the former star.

At $2^h\ 26^m\ 41^s$ A.M. a meteor appeared, followed by a long train, and was visible for about 4 seconds. Its course was from Cygnus, almost midway between Cassiopeia and Polaris.

At $2^h\ 29^m\ 16^s$ A.M. a meteor passed in the space of 2 seconds, from between Mars and Pollux to Procyon, leaving no streak.

At $2^h\ 35^m\ 56^s$ A.M. a meteor, which I can liken only to a most brilliant flash, passed from halfway between Cor Caroli and γ Ursæ Majoris to η Ursæ Majoris.

At $2^h\ 37^m\ 54^s$ A.M. one passed in about 2 seconds from between ϵ and ζ Ursæ Majoris towards β Ursæ Minoris.

At $2^h\ 44^m\ 1^s$ A.M. from α Ursæ Majoris to very near β Ursæ Minoris.

At $2^h\ 46^m\ 26^s$ A.M. from halfway between Mars and Procyon to 5° from Castor (towards the Pleiades): this meteor left a beautiful train, visible for several seconds.

At $2^h\ 48^m\ 46^s$ A.M. a meteor blazed out suddenly in a globular form equal to Mars in brightness, and was visible for 3 seconds, in the passage only from δ Leonis to β Leonis.

At $2^h\ 49^m\ 45^s$ A.M. a small meteor without train was observed from halfway between δ and β Leonis to a little below β Leonis; duration 2 seconds.

At $2^h\ 51^m\ 42^s$ A.M. from θ Leonis towards the horizon, slightly inclined to the north.

At $2^h\ 52^m\ 18^s$ A.M. from ζ Ursæ Majoris towards the north horizon: this meteor was followed by a long streak.

At $2^h\ 52^m\ 45^s$ A.M. a meteor appeared with a magnificent train. Its course was nearly parallel to γ and δ Ursæ Majoris, starting from about one-third the distance between γ and β Ursæ Majoris.

At $2^h\ 56^m\ 14^s$ A.M. from halfway between Mars and β Ursæ Majoris towards Capella; visible only about 5°; duration 3 or 4 seconds.

At $3^h\ 2^m\ 55^s$ A.M. another with course almost identically the same, leaving a train.

At $3^h\ 6^m\ 12^s$ A.M. from Cor Caroli towards the north horizon, brilliantly coloured, and visible for nearly 3 seconds.

At $3^h\ 10^m\ 36^s$ A.M. from ϵ Leonis towards Sirius.

At $3^h\ 20^m\ 10^s$ A.M. from θ Leonis towards the horizon.

HENRY J. SLACK, ESQ., Camden Square.

My wife and self saw about 1500. They were thick as hail (*not quite*) from $12\frac{1}{2}^h$ to $1\frac{1}{2}^h$. At and after 2^h they declined in number; and at $3\frac{1}{2}^h$ we gave up looking.

I examined a good many with the spectroscope, but could only see their spectra while very bright, on account of the quantity of diffused gaslight. I saw several green and yellow spectra of the *trains*, but none *pure* yellow. The spectra of the body of those I saw were much like those of Sirius as seen in some instruments. To the naked eye the trains appeared yellow, blue, green, and sometimes purple—nearly always, if not quite always, yellow, very conspicuous, like a train of minute closely packed golden sparks. This appearance was at the edges, and the middle blue or green. A considerable number, which had short, broad trains, exhibited prismatic colours. The great majority of those seen from S. to E. radiated most distinctly from points in Leo; many upwards and downwards from α Leonis, and others from γ Leonis. Numbers seen S.S.W. and S.W. had the same direction as if projected from E. upward to the zenith and then downward. Many with no tails burst in the midst of Leo near γ to the south. The luminous paths were exceedingly long, in hundreds of cases from 40°, 50°, to 60° and 90°. Many that were first seen about 40° above the horizon finished beyond the zenith down to the West.

Rear Admiral OMMANNEY, Paddington.

A few minutes after midnight I observed quantities of meteors shooting across the zenith to the north-west, about 12h 30m; the celestial concave was pervaded by the continuous and, in some places, the simultaneous discharge of meteors; no single observer could enumerate them. The most brilliant ones crossed the Great Bear towards the Pole-Star, and traversed Gemini, Taurus, and Orion, apparently coming from the south-east quarter of the heavens.

Very soon afterwards the radiant-point developed itself in a most remarkable degree of accuracy near the centre of a trapezium of stars in Leo: my eye was attracted by seeing the discharge of a distinct flash, which was soon followed by another of the same nature, having no path or lateral movement; this was repeated on the same spot during the shower; around this point the meteors appeared to emerge, making shorter or longer trails, according to the distance of emergence from the radiant-point, or, as it were, showing the angle of inclination made between the path of the diverging meteors and the focal meteors exhibited by the flash. On casting the eye round the celestial concave, the meteoric tracks manifested their having a common centre; for on retracing the vanishing trails, the lines of divergence all concentrated on the point observed in the constellation of Leo.

The radiant-point being at a low altitude during the shower, its position was the more accurately defined by perceiving some meteors descend from it directly down to the horizon, also to the south-east and south-westerly quarters. Very few meteoric paths deviated from the general lines of divergence from the focal point. About 1^h 10^m A.M. I observed a very distinctive meteor, having a broad light-bluish path, shoot from Leo across Orion below the belt and vanish about 5° beyond; its luminosity towards the termination of the path was visible at least two minutes, leaving a nebulous or cloudy expansion about the point of its disappearance.

About 1^h A.M. I observed one very remarkable phenomenon at the radiant-point, in the shape of a bright golden-coloured flash of a zigzag form (thus ≤); its extent was limited to one degree in arc; was visible for one second in time.

The shower was demonstrating its maximum effect between 12^h 30^m A.M. and 1^h 20^m A.M.; at 1^h 30^m a great diminution of meteors was apparent, by 1^h 45^m they were shooting at intervals. Owing to the vast showers of meteors which appeared in an exceptional clear atmosphere and cloudless night, the effect was marvellous and brilliant beyond description; but the meteors themselves, I think, were small in comparison to the shooting-stars generally observed on ordinary occasions; no head or nucleus was perceptible in any instance.

Previously to the shower I observed but one conspicuous meteor: about 11^h 30^m P.M., 13th, a bright yellow one flashed from east to west through an arc of 40°, at an altitude of about 15°, and parallel with the horizon in the south.

V. Fasel, Esq., F.R.A.S., Grammar School, Clapham.

From 0^h to 1^m A.M., saw 336 meteors in the northern half of the sky. Their numbers increased so rapidly that it soon became impossible to record their locality and appearance. About this time a few light clouds were prevailing.

From 1^h to 2^h A.M. the heavens presented a spectacle perhaps the finest that can be witnessed from the surface of our globe. The whole celestial vault was brilliantly illuminated by rocket-like trains of light in almost countless numbers. These fiery visitors were racing one after another, exhibiting at the same time bright hues of emerald green, blue, red, and sometimes orange. This was indeed a grand display, and all I could do was to endeavour to count them; yet very many were missed, owing to the rapidity of their succession. The greatest number took place from 1^h 7^m A.M. to 1^h 24^m A.M., during which interval I counted 465.

From 1^h to 2^h A.M. I counted 1118. After 2^h the numbers decreased rapidly.

The following Table shows the numbers seen in successive half hours:—

	h	m		h	m			
From	6	0	to	11	0	P.M.	7	were observed.
„	11	0	—	11	30	„	9	„
„	11	30	—	Midnight			12	„
„	0	0	—	0	30	A.M.	73	„
„	0	30	—	1	0	„	263	„
„	1	0	—	1	30	„	724	„
„	1	30	—	2	0	„	394	„
„	2	0	—	2	30	„	61	„
„	2	30	—	3	0	„	56	„
„	3	0	—	3	30	„	22	„
„	3	30	—	4	0	„	32	„
„	4	0	—	4	30	„	34	„
„	4	30	—	5	0	„	12	„
„	5	0	—	5	30	„	9	„
	Total						1708	

I estimate that the total number must have been four times as many.

The characteristics of the maximum display were the following:—

1. The general direction of the meteors was from east to west. Those which originated east of the radiant-point were retrograde, *i. e.* moved from west to east.

By the radiant-point is meant that point in the heavens from which all the meteors appeared to emanate. On this occasion that point was about the centre of the *sickle* in the constellation of Leo. When this constellation is on the horizon, it is situated somewhat to the east of the Great Bear. The radiant-point was on the horizon of London at 10^h 12^m P.M., on Tuesday, and on the meridian (*i. e.* at its greatest height) on Wednesday morning at 6^h 18^m A.M.

2. The meteoric trains of light were remarkably brilliant, and many of them of the shape of a spindle, being brighter in the middle of their path.

3. The greater number of the meteors were very bright, and in some instances as large as the planet Jupiter. Their colour was yellow, orange, and sometimes red, whilst the luminous paths were of a green or bluish hue, though in some cases red.

4. The trains were of two kinds—either of a continuous line of light, or presenting the appearance of luminous dust or sparks.

In order to make it intelligible what these trains of light are, and how to account for their existence, it is supposed that meteors becoming inflamed by entering our atmosphere are being consumed in their passage through it, and that the trail of luminous dust or sparks may be incandescent particles detached from the surface of the body both by chemical action and by friction. The air in front of the meteor is condensed proportionately to the resistance, *i. e.* to the square of the velocity, and consequently compressed hundreds, even thousands of times as much as in front of projectiles of ordnance; and in consequence of this compression it is raised to an intense heat which renders it luminous. The relative velocity of motion has been ascertained to be from 18 to 36 miles in a second.

5. The duration of appearance of the trains was, both in the east and west, from 2 to 14 seconds—in a few instances longer.

6. The longest and most brilliant trains were towards the west, varying from 2 to 20 degrees in length. Those in the east were comparatively short, about 2 or 3 degrees; but the duration of their appearance was quite as long as that of the former.

7. The meteors for the most part were observed to be about the Great Bear, Cancer, and Cassiopeia. They were rather rapid in tracing their course.

Before concluding, I must beg to direct the attention of observers to this fact, that after 2^h A.M., and after Leo had got up pretty high above the horizon, the meteors I saw from that time took a different course; they mostly proceeded from S.S.E. to N. by W.—as it were, towards the magnetic pole. This is a fact which I state in the hope of eliciting corroboration from observers; it would also add to the interest of the subject to know whether the magnetic needle was at all affected by the great shower *.

Auroral clouds, or diffused light, such as is often remarked during exhibitions of the Aurora Borealis, prevailed in the northern horizon during the earlier part of the night, and also immediately after the principal display. Vivid flashes of lightning were seen in the northern horizon at—

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* The magnets were not affected.—Ed.

h	m	s	
10	13	37	P.M. G.M.T., Nov. 13th.
10	43	35	
10	46	30	
0	36	39	A.M., Nov. 14th.
1	1	—	
1	20	—	
2	40	—	

At 5h 10m A.M. I saw with great interest an inclined cone of light, its base being upon the east horizon, and its summit at a certain height, reaching almost to Leo. This was a brilliant Zodiacal Light.

T. Sopwith, Esq., F.R.S., London.

I observed the southern part of the sky for upwards of half an hour on the morning of the 14th inst., viz. from half-past 1^h to a few minutes after 2^h A.M. From my window I had a tolerably wide view—exceeding 100° in range; and the objects near the horizon only intercepted from 6° to 9° above the level. I saw a great number of meteors, nearly all coming from near the constellation of the Lion, and passing, some above, others across, and some below the contellation of Orion, at that time directly in front, very clear and beautiful. Several of the meteors were as bright as Venus, and left a train behind visible for 2 seconds or more. I endeavoured to count them; but this was somewhat difficult when four or five were in view at one time; yet I came to the conclusion that there were not less than one in every two seconds, *i. e.* 30 in each minute, or 1800 in an hour. But this appeared to me to be a minimum; and therefore I think that, for at least 15^m after half-past 1^h, the rate was not less than 2000 per hour in that portion of sky which I could clearly see—say, 70° in height by 100° in width. This is the result I arrived at and noted down before seeing any accounts by anyone. It can scarcely be called "observation;" for, having had some rather arduous work the preceding day, and more in prospect, I could not sacrifice a night's rest, and took my chance of what was to be seen from my bed-room window. The greater number were of the brightness of stars of the second or third magnitude; few, if any, brighter than Venus; several as bright as Jupiter. Some suddenly disappeared; but I saw no appearance nor heard any noise of explosion. As Leo was just on the eastern edge of my view, I could see that at least $\frac{19}{20}$ of them came thence, some few having a more irregular path across the heavens. From repeated countings, I should say 2000 per hour was the rate for the period $1^h\ 30^m$ to $1^h\ 45^m$, and about half that number in the period $1^h\ 45^m$ to 2^h.

A. Claudet, Esq., F.R.S., Primrose Hill.

About a quarter past 1^h one of the meteors, starting nearly from the horizontal line of stars in Orion, crossed the sky towards the west; and, like all the others, the nucleus first disappeared after a momentary increase of brilliancy, leaving behind it a long line, the centre of which remained bright for some seconds. I continued to look at it, surprised that it remained so long visible. It appeared then as a streak about the length of two diameters of the sun, gradually becoming fainter and more confused; so that I was thinking if it was not some nebula accidentally situate behind on that spot of the sky, into which, as it were, it had dissolved itself. Still I did not lose sight of it; and after two or three minutes I observed that the spot remnant of the meteor was slowly going lower, in a line rather inclined to the west, but nearly coinciding with its meridian. At last it disappeared entirely, after having travelled, during 10 minutes, a length of two or three diameters of the sun.

The position of the spot where it began was about at an angle of 45° with the horizon. I am sorry my astronomical knowledge does not allow me to give more precise and detailed particulars; but I mention the fact, which, coinciding with observations of others, might be of some service in drawing conclusions upon the nature and movement of these extraordinary meteors. The situation from which I made the observation might be also of some importance, compared with the places of other observers.

I am sure that what I saw was the tail of the meteor, and not a cloud, because I followed it during all its phases very carefully.

Prof. A. S. Herschel, Glasgow, N.B.

A map of 83 meteors recorded here on the morning of the 14th inst., with the aid of Mr. A. M'Gregor, at the Observatory, shows that the radiant-point of the shower was in R.A. 149°, N.Decl. 24°. This is confirmed by my father's drawing of its position, pricked off from Bode's map, which I enclose. The place which it gives, corrected for precession since the date of Bode's Atlas (1801), is in R.A. 148° 25′, N.Decl. 23° 50′.

A list of about 50 meteors recorded by Mr. T. Crumplen and a friend, on Primrose Hill, and drawn upon a map which I have received, places the radiant in R.A. 147°, N.Decl. 24°. In the 'Times' of the 15th inst. Mr. G. F. Burder states that, by observing the meteors near the radiant-point, he obtained its position midway between the stars γ and μ Leonis; or in R.A. 149° 40′, N.Decl. 23° 40′. The position of this point appears therefore to be pretty well ascertained.

The time of the greatest intensity of the shower here was at 1^{h} 15^{m} A.M., when the number visible to a single observer seeing only half the sky (the other half being hidden by the Observatory buildings) fell one or two short of 60 per minute. The number at midnight, and again at half-past 2 o'clock, was one or two meteors per minute, which was the first and last appearance of the shower. On a moderate computation, about 8000 meteors must have been visible above our horizon in that time.

Three considerable meteors, which left streaks visible to the naked eye from four to nine minutes, appeared brighter than Venus. A fourth, which disappeared near the star ε Ursæ Majoris, at 2^{h} 42^{m} A.M., must have been nearly as bright as the full moon; for it lighted the interior of the Observatory. Its streak remained visible fourteen minutes. In our observations, a drawing of it represents its different phases. Only a small proportion of the meteors were as bright as the planet Jupiter; and of the rest the proportions, in their order of brightness, were about as follows:—

As bright as Sirius	10 per cent.
" 1st mag. *	30 "
" 2nd mag. *...........	40 "
" 3rd mag. * and under	20 "
	100

In general the nuclei and the streaks were white. A frequent colour of the nuclei, however, was a ruddy yellow, and of the streaks pale green. The contrast of these colours was brilliant, in certain cases, near the radiant. When first deposited the streaks had a compact, almost massive appearance; but those which remained visible the longest diffused themselves into clouds of light, generally of a yellow colour, which drifted slowly 10° or 12° in a southward course before they disappeared. Just as a row of flames seen one behind the other appears brighter than a single flame, this portion of the streaks occasionally grew brighter as it contracted itself into a knot.

I repeatedly examined the streaks through the body of a Herschel-Browning spectroscope. The instrument contains two prisms, which, together, separate the red from the blue rays of the spectrum about two degrees. The first observation made was of a fine green streak, which remained visible through the prisms for five seconds. It appeared to undergo no other alteration, excepting its curvature, than if it had been examined through an ordinary piece of glass. The following note was recorded:—

"0^h 54^m A.M. Equal to Sirius; from β Canis Minoris to β Eridani; left a streak for five seconds. The streak appeared as an extremely fine line in the spectroscope."

It may be noticed that the star β Canis Minoris itself is not visible through the prisms of the spectroscope, on account of their extraordinary dispersive power. In order to test the relative duration of visibility of the streaks in the spectroscope and to the unassisted eye, Mr. M'Gregor agreed to observe them with the naked eye, while I watched them in the spectroscope. Each called out "gone!" when the streak appeared to him to vanish. In cases where the same streak was watched the following agreements were recorded:—

"0^h 56^m A.M. Equal to a first-magnitude star; left a greenish-blue streak for three to four seconds. Agreement to within half a second.

"0^h 57^m A.M. Equal to a first-magnitude star; left a bluish-green streak for the same time. Agreement to within half a second.

"1^h 0^m A.M. Equal to Sirius; left a greenish-blue streak for five seconds. Agreement perfect."

In some cases the light of the streak was entirely dispersed by the prisms, and rendered invisible. Sodium and lithium were absent. Although I examined a great number, there were no signs of those metals being contained in the streaks. The foregoing observations, however, make it highly probable that a single green ray is the brightest part of their spectrum, which may be either the vapour of the rare metal thallium in combustion, or it may have a much more inscrutable origin in the bluish-green luminosity of Mr. Huggins's unresolvable nebulæ and comet-nuclei. Is it possible that the retrograde motion of the meteors may be explained by supposing the cloud to be a comet which, like Biela's comet, has become extinct?

After this we gave our attention to determining the radiant-point, and I had no other opportunity of renewing the observation of the meteor-spectra.

The following letter from an officer at Dover refers to the same subject:—

"Dover Castle, Nov. 15th.

"SIR,—Having, together with another officer of my regiment, carefully watched the meteoric shower which occurred on the night of the 13th, from 11^h P.M. to $2^h\ 30^m$ A.M., when the sky clouded over, I venture to trouble you with what struck us both, thinking it may prove of value in your spectrum analyses. When any colour other than yellow was present in the nucleus it was universally violet or rose-colour, and in some cases was very marked.

"The trains left by the meteors, on the contrary, whenever any particular colour was displayed, were green, very similar to the green band in the spectrum of thallium. We both remarked on the decided prominence, I might say sole display of these tints. In general the trains were white.

"I remain, &c."

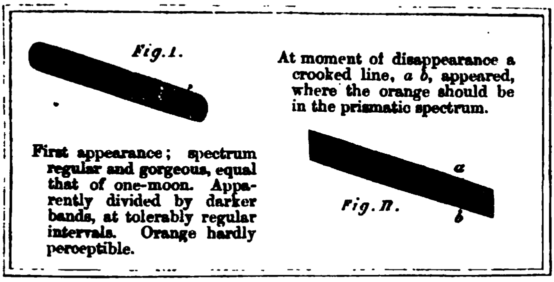
(Signed) "J. SEYMOUR DAVIES."

"*A. S. Herschel, Esq.*, &c."

Mr. Greg sent me the following notes of meteor-spectra:—

"The spectrum of the trains was feeble to a degree—I could hardly say that there was colour. The spectra of the three large ones that I observed much resembled in size and effect that of the crescent moon which I looked at last evening! I did not see the meteors with direct vision, and so cannot say how large they appeared naturally. They had all spectra like the enclosed (fig. I.), chiefly red (or crimson), green, and blue. Two of them were a little less marked at the outer edges and between the colours than this one; and they occupied, as compared with the field of view of the instrument, about this proportion (figs. I. & II., where I have roughly tried to give the effect). Not only was the

Nov. 14, 1866. *Spectroscopic Meteors.*



First appearance; spectrum regular and gorgeous, equal that of one-moon. Apparently divided by darker bands, at tolerably regular intervals. Orange hardly perceptible.

At moment of disappearance a crooked line, *a b*, appeared, where the orange should be in the prismatic spectrum.

line of demarcation between the red, green, and blue perfect, but also the outside edges of the prismatic spectrum; and there seemed to be pretty numerous darker *lines* across the spectrum in a vertical direction. At the instant of disappearance, I saw, or thought I saw, an orange line or band, as in fig. II., between the green and red, suddenly appear and disappear. It was not straight across, but deflected or jagged, thus ."

Sir J. Herschel, Bart., F.R.S., Collingwood.

"At $10^h\ 30^m$ P.M., Nov. 13th, we began to look out. At first *nil*. At $11^h\ 7^m$ I saw the first meteor, a fine one, with a train some 30° or 40° long; another at $11^h\ 13^m \pm$ passed below Mars *from* the radiant. At $11^h\ 22^m$ one under Mars (2nd mag.) shot *directly towards* the radiant. This also had a train. About $11^h\ 30^m$ another shot *right across* the paths of the regular divergents; 2nd mag.; slow, passing between α Ursæ Majoris and β Ursæ Minoris. These were the only two which I saw the whole night which did not conform: C. saw another.

"From about $11^h\ 30^m$ the number of meteors began to increase, and about 12^h–$12^h\ 10^m$ they were pretty frequent. From $12^h\ 11^m$ to $12^h\ 31^m$ I saw about 40 or 50 fine ones, *all trained*, not a single exception, as was the case throughout. At $12^h\ 31^m$ I went in, and came out about 1^h A.M.; and now they were getting exceedingly frequent, and the display was really superb. In the interval between this and $1^h\ 30^m$, when I went in again, I counted up to 600, and then left off counting; but the others who were on the roof of the house saw a great many more than I did. Frequently there were 3, 4, 5, 6, or more in such quick succession that their *trains* were coexistent. Very often two ran side by side, one a little behind the other, but not *lagging*. Their apparent velocity was remarkably uniform. In a *great many* instances (indeed most commonly) the *head* "SHOT AHEAD" of the train as a star or planet of a very high red colour. The trains to me looked all yellowish, though the others say that they saw blue and green. All the *trains* were *sparkling* like star-dust; but in two or three cases there was a remainder of cometic phosphorescent light, very persistent. In one which exploded with a flash close to α, β, γ Arietis (a flash which made F. look round, seeing objects suddenly illuminated) this cometic appearance lasted (fairly timed) 6 minutes! Its place at first was was close to α, β, γ Arietis, and its direction that of the train—about 2° or 3° long; but it drifted slowly southward, and at the same time *changed its direction*, until when it had got about 7° or 8° from its original place its direction was nearly at right angles to what it was at first.

"Another which left a cometic mass in the direction of the train was to the left of the radiant, about 10° or 15° from it, and its direction was about horizontal. This persistence of the trains (for this did *not* shift its place or direction) enabled me very deliberately to satisfy myself of a fact which I was already fully convinced of from the general inspection of the courses of all the meteors, viz. that γ Leonis is *not* the true radiant, but a point higher up in declination and in latitude.

"This point I have laid down on Bode's chart, from careful consideration of the whole phenomenon, on the enclosed paper, pricked off from Bode. In several instances meteors appeared *at* this very point, and in all such cases they were stationary and stellar, having no trains, but in some cases leaving on the spot a luminous smoke, proving that their direction was directly towards the observer.

"Dropping a perpendicular on the ecliptic, I find for the radiant for

1866, Nov. 13–14, Long.* 142° 10′, lat. +10° 15′.

"Now, on that date (midnight),

Long. of the sun seen from the earth... .... = 51° 25′

∴ Long. radiant—Long. of the earth .... = 90° 45′

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* Observe that Bode's chart being for 1801·0, +55′ must be added to the longitudes measured on that chart, for precession.

a much better coincidence than were γ the radiant, which would give 97° 5′.

"Hence it follows that the plane in which the meteoric bodies were moving was very nearly at right angles to the radius vector of the earth's orbit at the moment. Except, then, we assume that their place on Nov. 13th is at or very near an apse, they cannot be moving in ellipses of any great excentricity. As their orbit therefore is nearly circular, their absolute velocity is nearly equal to the earth's velocity in its orbit. The absolute inclination of their orbit is nearly twice the inclination of their apparent course to the ecliptic, or 20° 30′, their mean distance $=1$, and the direction of their movement retrograde.

"Professor Newton has come, I believe, to a conclusion of a retrograde motion, and in a nearly circular orbit. But—what then becomes of the 'Nebular Hypothesis'?—'a question to be asked' indeed!

"To finish my story. The maximum of the phenomenon was *very decidedly past* at 1^h 55^m. In the interval of about half an hour from 1^h A.M. to 1^h 30^m A.M., 600, as before said, were counted; but in the interval from 1^h 55^m to 2^h 30^m the number was much smaller; the phenomenon was evidently dying out. From 2^h 30^m to 3^h 10^m I went in again; and on resuming my station, I found that it had become cloudy. It soon cleared again, and was superb; but the meteors were now few and far between—none of the great-trained ones, but chiefly brief flashing ones. As this went on till I got tired of waiting for a fresh burst, I gave it up at about 3^h 30^m A.M.

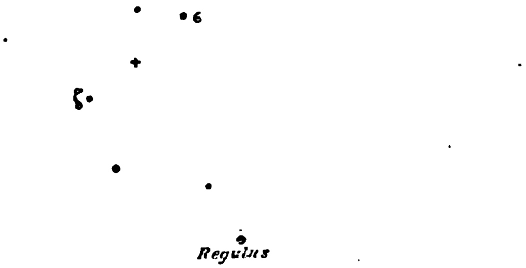
"J. F. W. H."

"Collingwood, 1866, Nov. 14th."

Dr. GLADSTONE, F.R.S., Nottingham.

I caught a view of a good many of the meteors in my spectroscope of Herschel's construction. The bright spark was resolved into rays of all the colours; but in one instance, at least, I noticed a very decided maximum of light—I think, in the yellow. The trains appeared through the spectroscope very much the same as they did without it; hence the light must have been mainly uniform, or nearly uniform, in refrangibility; but what the ray was I do not know. Unfortunately I had no absorbent media at hand to determine it; and the observers around me gave contradictory opinions as to its colour. On theoretical grounds I suppose it was the dull red of a heated body becoming cold; but it may have been the sodium D.

Enclosed is a tracing of a drawing I made of the "Sickle" at the time, so as to mark the point from which the meteors seemed to radiate. Just at this point (the cross between ζ and ε Leonis)



I once saw as it were a star appear, increase in brightness till of about the first magnitude, and then disappear, without apparent motion, evidently a meteor coming straight towards me.

The usual history of a meteor during its luminous course seems to be that it increased in brilliancy till it suddenly vanished, leaving behind it a train which was not uniformly bright; for the middle of the train seemed more luminous or larger than either its beginning or its end. The whole appearance was just what might be expected if a small piece of metal had ignited and burnt more and more furiously as it proceeded, till there was nothing left of it, except the hot oxide or ash remaining behind. I did not see any meteor explode or throw off sparks, beside the trains; but two instances were noticed by others at Nottingham. Once, however, I saw a bright blue spark fall very rapidly almost at right angles to the meteors streaming through Orion, and leave nothing behind it.

Rev. Robert Main, F.R.S., Oxford Observatory.

As early as the evening of November 12 a strict watch was kept up for the appearance of the meteoric shower; but the night proved unfavourable, the whole sky being overcast, with the exception of a few minutes, when a few of the brighter stars showed themselves in a short gap in the clouds near the zenith at $3^h\ 30^m$

A.M., the wind being all the time very high, and the rain falling at intervals.

The next night (November 13) was, generally speaking, a bright one; the afternoon was clear; but shortly before 11ʰ the clouds suddenly made their appearance. It began to rain, and for a moment there seemed to be little prospect of having a good view of the expected display. But the clouds quickly drew off again; and though they interfered occasionally with the observations, they did not materially prevent the observing of the phenomena. A few minutes after 11ʰ Mr. Lucas began the observations of the meteors, and was joined by Mr. Quirling at 12ʰ, the meteors making their appearance now and then, so that it was possible for Mr. Lucas, who undertook the noting down of the observations, to take many notes as to locality and appearance; but very soon they made their appearance in such numbers that it was found impossible to do more than count their numbers, Mr. Lucas watching the portion of the north sky of the prime vertical, and Mr. Quirling that from the prime vertical to the south.

This great display began about 13ʰ (or 1 o'clock in the morning), and reached its *maximum* at about 13ʰ 24ᵐ, after which time it gradually began to slacken. The watch, however, was kept up till 18ʰ, though after 15ʰ there were not many meteors seen. In all, there were observed not fewer than 3090 during the night, of which about 2000 fell between 13ʰ and 14ʰ, or between 1ʰ A.M. and 2ʰ A.M. As to the general appearance of the meteors, it was noticed that the majority of them were of a whitish or yellowish colour. Some, however, were reddish or orange-coloured, and one meteor was noticed to be bluish. The brightest left generally a train behind them, which was to be seen for a few seconds after the meteor had disappeared.

In one particular instance the train of a meteor was visible for some minutes: this was the train of a bright meteor which disappeared in the belt of Orion, leaving the train apparently attached to ζ Orionis, and giving to that star the appearance of a comet with a tail of nearly 3°, standing out at a position-angle of nearly 135°. It then detached itself from the star, keeping up the same route as the meteor, but forming itself into a ball of faint cometic appearance of about 15′ diameter, which grew dimmer and more diffused, and disappeared altogether after a lapse of about 4ᵐ to 5ᵐ at a distance of nearly 1° from ζ Orionis, at a position-angle of about 200°. This meteor appeared at the time of the greatest display, at 13^h 24^m. Only in two instances meteors were seen to burst—one in the east, and another in the north.

It may finally be remarked that there was at one time seen the flash of distant lightning coming from a dark cloud near the north horizon, and that some time before sunrise the zodiacal light was noticed to be unusually brilliant.

The photographic sheets did not indicate any active electricity at the time of the display.

Lord Wrottesley, F.R.S., Wrottesley Observatory.

I observed from 12^h 30^m to 1^h A.M. Greenwich mean time. My window commanded a view of the heavens extending from about E.S.E. to S.W., or from Procyon to near the extremity of Cetus, and from the horizon to about the altitude of Aldebaran.

During this half hour Lady Wrottesley and myself counted 209 meteors; but the number must have been greater, as occasionally, but rarely, more than one was visible at the same time, and the attention was distracted. All the meteors shot from the east towards the west; and, with scarcely any exception, their course was at first in a line at right angles, or nearly so, to the three stars in the Belt of Orion. About three of those I observed myself were of a brilliancy exceeding Jupiter. One meteor appeared to commence its course from Procyon; and another burst in the Belt of Orion. Almost all those which burst displayed red sparks. A great many first became visible between Procyon and the Belt of Orion.

I enclose the observations by Hough and Simpson, the gardeners, which were made in the open air, each standing with his back to the pillar supporting the meridian mark. Ours were made with the window shut.

Messrs. Hough and Simpson, Wrottesley.

[The observations are all G. M. T.]

Observations commenced at 1^h 10^m A.M. At this time the sky was clouded, except a small portion in the north-east, where Ursa Major and Leo were visible. Through these constellations meteors were darting in rapid succession, about thirty per minute.

About $1^h\ 25^m$ A.M. five meteors were seen at once; three at once were seen five or six times, two at once several times by the same observer.

At $2^h\ 0^m$ the clouds had cleared away, and countings were made of the meteors seen during ten minutes by two observers, one looking east and the other west, with the results given below. The paths of nearly the whole of them, prolonged backwards, appeared to intersect in a point near, perhaps a little to the west of γ Leonis. Their apparent size was generally that of stars of the first or second magnitude; certainly there were more above second magnitude than below it. The colour of the greatest part of them was either orange or red, that of their streamers generally greenish blue; this greenish blue was also the colour of four meteors, which much exceeded the others in size and brilliancy. All of them left streamers, which were visible from five seconds to thirty seconds, the streamers of the brightest meteors being visible the longest.

Number of meteors counted.

Seen in the East. Time. h m		h m		No.
2 0	to	2 10	......	63
2 17	"	2 27	......	45
2 35	"	2 45	......	35
2 50	"	3 0	......	40
3 14	"	3 24	......	30
3 30	"	3 40	......	24
3 50	"	4 0	......	13
4 15	"	4 25	......	7
				257

Seen in the West. Time. h m		h m		No.
2 0	to	2 10	......	67
2 17	"	2 27	......	61
				47
				53
				44
				23
				27
4 15	"	4 25	......	17
				339
				257
			Total ...	596

Times of the four largest meteors, and approximate positions of points where they disappeared.

Time. h m	Right ascension. h m	Declination.
2 41½	18 40	+50°
3 6½	12 40	+15°
3 25	11 0	+33°
3 56	passed over δ Arietis, and disappeared a little to the west of that star.	

C. H. Weston, B.A., Lansdowne above Bath.

The station from which the following observations were made was such as to command a visual radius varying from twenty to twenty-five miles, and was free from the counteracting glare of artificial light. These circumstances may possibly account for the absence of all reference to the electrical conditions of the atmosphere by other meteoric observers, and especially to the omission of any mention of the existence and continuous prevalence of a delicate though decided Aurora Borealis during the exhibition of the meteoric (or, more correctly, the planetoid) phenomena.

Monday Night, November 12th.—Cloudy, with unusually heavy rain, the ground-pluviometer showing as much as 0·985 of an inch of rain fallen; but while the sky was found at different times during the night to be overcast, yet a more than ordinary amount of light pervading the atmosphere was distinctly observable, leading, after the next day's experience, to the inference that electrical forces were in operation then, as they proved to be on the subsequent day.

Tuesday Night, 13th, and Wednesday Morning, 14th.—Meteorological conditions:—Wind W. & W.S.W. & W.N.W.; horizontal movement about thirty-five miles per hour (or force = 3); sky clear, with occasional driving cumulo-stratus clouds, sometimes degenerating into nimbus; atmosphere showing local condensations of moisture, and consequent optical exaggeration of the apparent disks of the stars.

Electrical conditions:—The atmosphere was charged with *positive electricity*. *Lightning* (sheet) frequent in the N. & N.W. Greenwich mean time 10^{h} P.M. *Aurora** extending from N.W. to S.E., producing almost crepuscular light.

Sheet lightning continued (11^{h} P.M.). *Aurora* now brilliant, exhibiting a broad strong band of silvery light along the horizon, streaming upwards in fleecy forms, and giving a modified moonlight appearance to the heavens and the earth's surface; and some splendid meteors were seen in the north-east, and afterwards increased in numbers.

A very heavy squall now occurred (11^{h} 50^{m}), bearing with it a dense nimbus cloud, with a driving rain-scud. Meteors were seen coming from over the black cloud into the clear sky; and where the nimbus was thin the meteors were visible through the clouds.

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* The magnets at Greenwich Observatory were not disturbed at all.—EDITOR.

After the clearing of this heavy scud the heavens remained cloudless till after sunrise.

Midnight.—Meteors now largely increased in numbers.

12^h to 1^h A.M. Meteors very numerous—increasingly so; one passed across Canis Major, now in the S,E., and bursting (or attaining its maximum ignition) with a rosy light near Sirius, absolutely paled that resplendent star.

1^h 30^m–2^h 30^m.—Meteors. The maximum exhibition now occurred, amounting in the quarter observed (N.E. & S.E.) to about 600 per hour, averaging about ten per minute. Their numbers, however, were doubtless much larger, as frequently several meteors appeared to burst simultaneously.

3^h–4^h A.M.—Meteors were now decreased in numbers in the same quarters to about 200 per hour, or nearly 4 per minute.

Aurora was now lessened in brilliancy.

4^h 30^m A.M.—Meteors became at this period more rare.

5^h 25^m A.M.—Aurora appeared to assume (at about two hours before sunrise) a different appearance. Instead of a band of silvery brightness, the light had become more diffused, making even the furniture visible in a room facing the north-west.

The time of the actual local rising of the sun (as stated *infrà*) clearly shows that this light (whether auroral or arising from any other source) was certainly not crepuscular.

5^h 25^m. A.M.—Meteors, and some very fine. Two were observed also to cross Canis Major (now in the S.W.), and to burst near Sirius; and one, assuming a bluish light, equalled Sirius in brightness.

6^h A.M.—Meteors. One meteor of considerable size passed at this time along the south-eastern horizon, and was distinctly visible against the delicate amber glow which now suffused the south-eastern sky.

7^h 25^m. A.M. *Sun.*—The sun now began to rise over the distant chalk range of Wilts, tinging with red the cloudless sky.

Characters of the Meteors.—Some of them, after a very short course of (apparently) a few feet, burst; others exhibited an almost continuous sparkling track (for a second or more), like a sky-rocket, and burst; of others the bursting sometimes produced (few or many) scintillations, and at other times more resembled the explosion of sky-rockets, dropping in golden diverging points. Some, however, were like Roman candles, assuming a *round* luminous head, and leaving a smooth and not scintillating track.

Colours.—These were various—resplendent white, blue, rosy, yellow, and golden.

Direction.—The great mass of meteors moved from E. & N.E. to W. & S.W.; a few seemed to descend from the zenith to the horizon in a contrary direction, viz. from W. & S.W. to E. & N.E. But this apparent difference arose, doubtless, from an optical deception, resulting from the position of the spectator being in a line with, and to the west of, such falling meteors, which would give the apparent retrograde movement.

The grand general course was E. & N.E. to W. & S.W.

Height.—From the statement given (*suprà*) of the midnight rain-scud, it is clear that these meteors were above the clouds.

Lat. 51° 24′ 30″. Long. 2° 1′.

Height above mean sea-level 740 feet, approximately.

Rev. T. B. Snow, Downside, Bath.

I have great pleasure in forwarding you an account of the phenomenon of Wednesday morning last. Fortunately a tolerably clear night enabled us to have a good survey of the heavens. Some heavy cumuli hung from N.W. to S.; but although a strong breeze of 5 or 6 lb. pressure continued all night from the W.N.W., scarce a cloud crossed the zenith, thus leaving the north and east clear; indeed from $2^h\ 30^m$ till 5^h the sky was cloudless. In order to note the circumstances desired by the Committee, I had constructed charts in accordance with the columns in the forms sent, and in them divided the hours into periods of five minutes, hoping thereby to be able to record some fact of interest; but the astonishing rapidity with which the maximum density of the shower arrived quite frustrated all attempts at minute descriptions of individuals, and I was compelled to be content with what general results I could glean amid the novelty and excitement of the scene. Passing by as out of place remarks concerning the æsthetical character of the spectacle, I will proceed at once to facts; and I think they will be best grouped by keeping to the heads recommended in the Committee's forms.

1. *Number.*—My arrangements provided for a watch from midnight till daybreak, with two assistants. At $10^h\ 30^m$ I went out for 10 minutes, but could not observe any of the expected visitors. I went again at $11^h\ 30^m$, and in the succeeding 10 minutes saw 5. Operations having thus commenced above, I called my assistants to begin ours below, and on the way to the observatory we

reckoned 20 between 0^{h} and $0^{h}\ 15^{m}$. The numbers registered in the charts were as follows:—

	h m		h m		
From	0 15	to	0 20	were registered	18
„	0 20	„	0 25	„	18
„	0 25	„	0 30	„	7
„	0 30	„	0 35	„	17
„	0 35	„	0 40	„	26
„	0 40	„	0 45	„	43
„	0 45	„	0 50	„	68
„	0 50	„	0 55	„	92
„	0 55	„	1 0	„	143
„	1 0	„	1 5	„	207

Until $0^{h}\ 30^{m}$ the west and north were not under observation; after that we went outside, yet up to one o'clock I have no doubt many escaped us. At 1^{h} it was impossible to enumerate them, and we could but stand and admire the wonderful scene. In order to have some estimate of the increase or decrease, I took minute observations at stated periods with one person facing the north; and as they were equally plentiful in all parts of the heavens, an approximation may be obtained; the following was the result:—

	h m					
At	1 25	a person facing	the north	saw	40	a minute.
„	1 30	„	„	„	28	„
„	1 35	„	„	„	27	„
„	1 40	„	„	„	19	„
„	1 45	„	„	„	6	„
„	2 0	„	„	„	6	„
„	2 15	„	„	„	7	„
„	2 30	„	„	„	4	„
„	2 45	„	„	„	4	„

A person stationed at the south at $1^{h}\ 15^{m}$ saw 44, at $1^{h}\ 20^{m}$ saw 90, and another in the east at $1^{h}\ 10^{m}$ saw 92. From this I estimate the maximum density of the shower to have occurred at $1^{h}\ 10^{m}$. There was a gradual accelerated increase from $0^{h}\ 40^{m}$ to 1^{h}, and a sensible diminution at $1^{h}\ 30^{m}$, and the extreme brilliancy of the shower may be said to have subsided at $1^{h}\ 45^{m}$. The following is my estimate for the rest of the morning:—

	h m		h m			
From	3 0	to	4 0	an average of	3	per minute.
„	4 0	„	5 0	„	2	„

After 5^{h} they became rare.

2. *Size.*—Regarding Venus as she appeared on the night as

a standard, the proportion between those larger and those smaller than the planet seemed to vary with the time. At a rough estimation the following was the result of my consideration:—

	h	m		h	m					
From	0	0	to	0	30	those larger than	Venus	were	8	per cent.
„	0	30	„	1	30	„	„	„	4	„
„	1	30	„	2	0	„	„	„	3	„
„	2	0	„	5	0	„	„	„	10	„

I should say that about 20 were considerably larger, but yet none so large as to be classed among the brilliant meteors that are seen occasionally at other times of the year.

3. *Colour.*—They seemed to me to be remarkable for the absence of all colour, chiefly having the ordinary pale lustre of the stars. A few, however, had a tinge rather than a decided colour, somewhat resembling the tinge frequently seen in the light of the glowworm. One at 0^h 12^m had a blue appearance, another at 0^h 26^m was red; again, another at 1^h 10^m was blue, and a large one at 2^h 17^m was decidedly yellow. Several of the larger ones were seemingly of a different kind, and had an appearance of flame, which no doubt gave rise to the common epithet of fireballs. The colour of the trails I defer to the head "appearance of the path."

4. *Duration.*—Of the meteors themselves, the great majority scarcely lasted a second; and none, I think, exceeded two seconds. Perhaps the proportion of those lasting between one and two seconds might be estimated at 6 per cent.

5. *Position,* or *Altitude and Azimuth.*—Their multiplicity precluded all attempts at fixing precisely the altitude or azimuth of any; only general results can be estimated. The general direction of the *start* was undoubtedly east to west. They sprung from all parts, from the horizon to the zenith—some with a straight path, some in various curves, and some apparently in double curves. Some were seen to start from Leo together, and then diverge in opposite curves to the north or south. Some passed across the zenith in straight lines, occasionally two in parallel lines; while others seem to have completed their curve in the distance, presenting to view the external part of it. The only circumstance that apparently militates against the theory of their proceeding from γ Leonis was that a few passed from north to south: these were under 10, and their course could no doubt be explained by a difference in their distance from the main body—outriders as it were. I found, too, that the proportion in their different positions varied somewhat with the time, in the following manner:—

	h m		h m	
From	0 15	to	1 15	they passed freely from east across the zenith.
„	1 15	„	2 0	they seemed principally to branch to the north and south, and not so freely over head.
„	2 0	„	3 0	they seemed a little lower in the heavens.
„	3 0	„	4 0	there were but a few in the east, more north and south.
„	4 0	„	5 0	almost entirely in the *west*, but as coming from the east.

The change in the point of appearance from 3^h to 5^h I attribute to a curious diffused light that spread over the N.E. and E. and dimmed considerably the lustre of the stars. It somewhat resembled a weak diffused aurora. Another curious feature about those that appeared in the west between 4^h and 5^h was, that they were chiefly in straight lines and much more inclined to the earth, and so much so that I think some must have reached the earth at no great distance. I have heard of nothing of the sort in the neighbourhood; but a thing of the kind is not likely to be discovered, owing to the unseasonableness of the hour.

6. *Appearance of the streaks.*—The trails belonged, I think, to by far the great majority. Their form, of course, corresponded to the course of the meteor. Several I noticed were disjointed; *i. e.* the trail would cease, and recommence a little further on; also in others the nucleus seemed separated a little from the trail. The colour of the trails seemed uniform, the pale starlight, with a slight bluish tinge. Their duration varied from one to five or six seconds. About a half did not remain more than one second, and a third did not exceed two seconds. A large meteor at $1^h\ 11^m\ 30^s$ left one whose duration was fifteen seconds; but this was an exception. After it disappeared, a dull diffused light spread over the space it occupied, and remained for some minutes. I had the good fortune to catch a trail in our 15-inch equatorial; for after the brilliancy of the display had subsided I endeavoured to get a view of one through the telescope. After waiting some time, one shot right across the field of the instrument. The velocity prevented a glimpse of the nucleus; but the trail lasted two seconds; and the impression it left on my mind was, that the trail was divided down the middle of its length, and that the luminosity appeared on each side of the division. An example will illustrate my meaning: it seemed, as one might imagine, the furrow of a vessel, with the foam on each side, as seen from a great

height, the light seeming to disappear when the furrow closed up. Due allowance must be made for the brief duration of the object, and the unknown distance requiring some focal adjustment; for the instrument was focused for stars of the fifth or sixth magnitude; still the impression left was as I have described. I could discern no motion to account for the curious phenomena observed by Mr. Heath, recorded in yesterday's 'Times.' To the apparent division of the path, I am inclined to attribute the blue tinge almost uniformly observable. The length of the different trails varied up to 60°, and, as far as I could estimate, in the following proportions:—

40° to 60°	……	1 per cent.
20 „ 40	……	3 „
0 „ 20	……	80 „
No trail.	……	10 „

This is but a rough estimation, as the rapid obliteration, varied curves, varied distances, and their multiplicity prevented anything but a hasty calculation. An observer represents a large one to have extended 80° or 90°.

7. *Velocity.*—I can give but little information on this head. The absolute velocity of any I could not determine even approximately; but relatively, the large ones seemed to have a less, and those with larger curves a greater velocity; but on this point deception is so easy that I am not at all confident that my conclusions are trustworthy.

8. *The Bursting.*—I did not notice any to be fractured into splinters, and the portions scattered; but about ten of the largest seemed gradually to increase in size, assume the appearance of flame, and then mysteriously disappear. The flame had a brilliant yellow tinge, and disappeared with a red or a blue tinge. Three of these appeared in succession at $2^h\ 16^m\ 30^s$, $2^h\ 17^m$, $2^h\ 18^m$: one was brilliant enough to cast a shadow.

This is the general result, as it appears to me, of the grand spectacle. I was not fortunate enough to view any other in the telescope: I saw a minute one in the field, that could not have been seen by the naked eye; but its velocity was so great that I could not even determine whether it left a trail. The trail that I did see in the glass left a diffused light over the space it occupied after its disappearance. The barometer stood all the time at 29·248 in., which is above the normal pressure of the atmosphere at our height above the sea. The thermometer did not descend below 40°. There was, of course, no sound or odour perceptible, on account of the high wind.

James Mottram, Esq., Norwich.

At 11^{h} P.M. I commenced my watch for the meteors from my garden in the Lower Close, and continued to do so, with the intermission mentioned below, till 11^{h} 52^{m} P.M.

	h	m		h	m		
From	11	0	to	11	15	counted...........	4
„	11	15	„	11	30	„	10
„	11	30	„	11	45	„	12

Clouds then covered the sky; there was a smart shower; but by midnight it was clear again; and

from	12	0	to	12	15	there were	28
„	12	15	„	12	30	„	36
„	12	30	„	12	41	„	38

Clouds again intervened till 1^{h} 10^{m}; then

from	1	10	to	1	15	there were	24
„	1	15	„	1	30	„	190
„	1	30	„	1	45	„	130
„	1	45	„	1	52	„	29

when, clouds having again come over, I relinquished my watch. During the same time there were at least 50 more, which, from their faintness or other causes, I did not accurately note. I placed myself looking about E.S.E. During this time there were certainly not above five meteors which could be said to proceed towards Leo. The wind was from N.W.; and the 24 which were noted from 1^{h} 10^{m} to 1^{h} 15^{m} were all seen in a very small space in the northern horizon, from which the clouds were then beginning to lift; all were nearly parallel to the horizon, and shot from east to west. I was much struck during the earliest part of the time with the inclination of 3 or 4 meteors to follow one another in very quick succession in almost the same track, which would perhaps be free from meteors for some time afterwards. Between 11^{h} 15^{m} and 11^{h} 30^{m} three took almost the same course from β Orionis to γ and ζ Eridani. These were all very bright, and left long trails behind them. I thought, on two occasions, there were loud reports; but I could not connect them with any particular meteor, and even at night there are so many noises in the city that I cannot be certain about this.

About 11^h 30^m two bright meteors fell almost perpendicularly between α Andromedæ and α Pegasi.

Between 12^h and 12^h 15^m three shot up in quick succession from the horizon, between the paws of Ursa Major; also from that time to 12^h 30^m several shot from α Tauri, from Orion's belt, and great numbers also shot through Gemini.

Around the latter constellation the greater number appeared between 12^h 30^m and 12^h 41^m, there being few to the west of Orion.

After 1^h the numbers increased, so that I paid more particular attention to that fact, and thus found less opportunity to mark with any precision their course, which, indeed, was in all directions from Leo.

JOHN GRAHAM, Esq., Darlington.

The shower of meteors predicted by astronomers was well seen here on the morning of the 14th inst., the state of the atmosphere having been extremely favourable for observing the phenomenon. As early as 11 o'clock on the previous night some very fine ones were seen rising in the east, and darting across the sky in various directions. They grew more numerous as the night advanced. The point of apparent divergence was evidently near the eastern horizon. This point was indicated with remarkable precision, whether the meteors started near it or in a remote part of the sky.

They continued increasing in frequency. From 12 to half past 12, 320 were counted. They now became so numerous that the attempt to count them had to be abandoned. The main shower may be said to have lasted from half past 12 till half past 1. During that hour it is impossible to convey an adequate idea of the grandeur of the scene presented; the heavens seemed perfectly alive with them. They darted out from all parts of the sky, and pursued a westerly course, frequently in pairs, as if racing. As some vanished others appeared, thereby making the shower continuous. The average number in constant view during this hour must have been about 20.

The brightness and length of their trains were very variable. Many appeared to be as bright as Sirius, but none brighter. The colour of all appeared to be either orange or red, and the trains green. Those seen near the point of apparent divergence seemed sometimes stationary, at other times to have a very slight motion. The trains of those in that locality appeared comparatively short, of those in the west much longer, whilst the trains of those which passed to the north, south, and over the vicinity of the zenith appeared longer still. The trains remained visible (and in the larger ones for a considerable time) after the disappearance of the heads, their middle parts being the last to disappear.

At half past 1 their frequency had sensibly diminished; but very many fine ones continued to appear at intervals, either singly or two, three, or four at a time, till the near approach of dawn.

The number of meteors seen on this occasion must have been several thousands; and it was very remarkable to find with what exactness they appeared to diverge from a central point. The numbers of stragglers seen, or those which did not appear to move in harmony with the fiery host, did not exceed ten.

The central point from which the meteors appeared to diverge was found to be about 1° south of ζ Leonis; the approximate position of the central point was therefore right ascension $10^h\ 6^m$, north declination 23°.

At $12^h\ 35^m$ a flash of lightning was seen; others appeared at intervals of 20 or 30 minutes till half past 3. Much diffused light pervaded the sky, especially near the horizon, and more particularly in the east.

Though the fiery shower was passed, there appeared at $3^h\ 47^m$ a phenomenon much more startling than that. It appeared like a serpent, of symmetrical form, and of such brightness as to impress me with the idea of solidity: it was coiled up. The apparent diameter of the coil was about three times that of the moon. I called a witness, who pronounced it to be like a conger eel. A star of the fourth magnitude in Leo Minor appeared to be exactly in the centre of the coil, the position being right ascension $10^h\ 23^m$, north declination 36°. For 2 minutes no change of position could be observed, although it was agitated by a tremulous motion. It then began to move, at first very slowly, gradually to uncoil itself and expand its proportions; its course was southward; its motion became accelerated, and simultaneously its size increased and brightness diminished. Eventually it assumed a parabolic form, the apex taking precedence, and finally vanished at $3^h\ 55^m$, having been visible 8 minutes and traversed a space of about 15°. The point where this object appeared is 13° north, and slightly east of the point of apparent divergence of the meteors. It is worthy of remark that it passed through and disappeared near that place. It is much to be desired that this remarkable object may have been seen at distant places. The sky was very clear, and nearly cloudless throughout, a strong breeze blowing from the west.

JOHN SOUTHALL, Esq., Leominster.

1. The sky was mostly brilliantly clear; but a few patches of light rain-cloud or mist floated about. There was a flash of lightning in the north-east about $12^h\ 45^m$. There was a strong phosphorescent or auroral light in the east and north-east.

2. The meteors increased rapidly in number until about $1^h\ 15^m$ A.M., at which time I counted in the east, with an imperfect field of view, thirty-six in a minute. At this time the total number can hardly have been less than 100 per minute. $1^h\ 15^m$ A.M. was the time of maximum intensity, as far as could be ascertained.

3. The meteors varied from a size larger than Venus at its greatest brilliancy to small streaks of light a degree or two in length. Perhaps the greatest number took a course from north-east to north-west, about 30° above and nearly parallel to the northern horizon. In some cases, after disappearance, they apparently reappeared at a little distance and continued their flight.

4. The colour of the meteors varied from white to orange. The trains were frequently of extreme beauty, and exhibited a vivid phosphorescence of a greenish-blue colour, very similar to that seen upon shells or mother-of-pearl, but rapidly vanishing. In two or three instances the wreath of smoke left behind remained visible for some time.

5. The point of disappearance of some of the meteors in the *north-west was marked by a small red spot, which remained stationary and visible for several seconds.*

At 2^h A.M. the number of meteors had much decreased, and the sky became more cloudy.

G. C. THOMPSON, Esq., Cardiff.

Observations were commenced at midnight and continued till 5^h A.M., November 14th, with the exception of about ten minutes from $12^h\ 25^m$ to $12^h\ 35^m$, and the half hour after 3^h A.M.

A very large proportion of the meteors seen were equal to stars of the 1st and 2nd magnitude; a few, six or eight, larger than those of the 1st magnitude.

All the meteors, with two or three exceptions, were attended by trains. The trains were very brilliant in comparison with the nuclei; many of them had a greenish tinge. The train was visible mostly for one or two seconds after the disappearance of the head, in some instances for longer times, up to a minute, and in one case for twelve minutes: this last assumed a serpentine, and several of the others a curved form after the disappearance of the head.

Of the meteors which appeared in the immediate neighbourhood of the Sickle in Leo, many traversing a small arc, say 1° to 2°, appeared to have no nucleus; the trains of these were often slightly curved, and tapered towards each end. All the meteors with the exception of about six, came from the direction of the Sickle in Leo.

At midnight the sky was clear after a shower at 11^h 30^m P.M., November 13; several meteors were seen in the first two or three minutes.

At 12^h 15^m a bank of cloud rose from the north, and spread till nearly the whole sky was covered at 12^h 25^m, when there was a shower of rain.

At 1^h 35^m the sky was quite clear and cloudless, as it remained, with the exception of low clouds on the horizon at times, afterwards.

About 1^h 25^m and afterwards, a diffused light, changing its position slightly at times, and sometimes intersected with streaks of dark (clear) sky, was noticed in the north and east. The stars shone through this light with undiminished lustre.

At 2^h 41^m a flash like distant lightning.

The time of greatest frequency of the meteors was between 12^h 50^m and 1^h 35^m. From 1^h 40^m to 5^h the meteors steadily decreased in frequency.

The following are the numbers of meteors counted by two observers, sitting facing opposite points of the compass.

	h	m		h	m		Meteors.
From	12	38	to	12	43	five minutes...............	162
,,	1	26	,,	1	31	,, ...	231
,,	1	44	,,	1	49½	five and a half minutes	107
,,	2	11	,,	2	16	five minutes..............	52
,,	2	40	,,	2	45	,, ...	27
,,	4	5	,,	4	10	,, ...	23
,,	4	50	,,	4	55	,, ...	15

The night of November 12–13 was cloudy and rainy.

Observations of

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1866. Nov. 14	h m 0 53 A.M.	Cardiff...	1st mag. *	....	....	Passing from east to west, just south of, but very close to ζ Tauri and α Tauri; rather nearer the latter.
,, ,,	0 56 A.M.	,, ...	1st mag. *	....	....	From near α Persei passing directly over γ Andromedæ.
,, ,,	1 8 A.M.	,, ...	Three times size of Jupiter.	Nucleus purple.	....	From direction of Castor through Pleiades.
,, ,,	3 51 A.M.	,, ...	Equal to Jupiter	Reddish	....	From near α Cassiopeiæ vertically downwards towards λ Andromedæ.

Luminous Meteors.

Appearance; Train, or Sparks; Streak, if any left, and its Duration.	Length of Path.	Radiant-Point; Direction; Slope of Path.	Remarks.	Observer.
Brilliant train ...	About 25°	....	....	Geo. C. Thompson.
....	About 25°	....	....	„ „
Train some minutes broad; at first quite straight; a part, about 15° long near the Pleiades and Aldebaran, remained visible after the ends had faded, and assumed a serpentine form; after this, it took the form of a small oval luminous cloud, and moved from between ε and ζ Tauri towards γ Orionis; visible as faint cloud near γ Orionis till 1^h 20^m.	About 45°	....	This was the brightest meteor observed during the night.	„ „
Nucleus increased gradually in brightness, and disappeared suddenly. Train visible about one and a half minute.	About 20°	....	....	Geo. C. Thompson, H. W. Thompson.

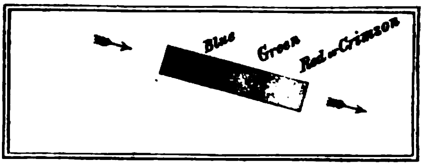
R. P. Greg, Esq., Manchester.

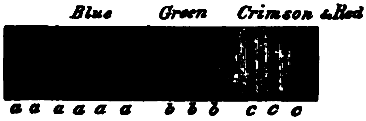
November 14, 1866.

The meteoric display was superb. The *maximum* at 1^h A.M., only lasted half an hour, when *one* observer could count fifty meteors in sixty seconds. I have written Herschel fuller particulars.

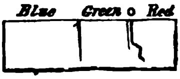
November 15, 1866.

Except in the case of three meteors, probably large ones, I saw nothing remarkable with the spectroscope lent me by Herschel. Most of them, and the trains especially, appeared so faint as to be almost colourless. In the case of the three I allude to, the appearance was gorgeous—much the same as looking through the instrument at a one-third moon. In the case of two of these I saw no streaks, or lines, or bands, and the general spectrum was a little diffused and blurred at the edges of the spectral appearance. In the case of the third, however, the spectrum was perfectly defined and occupied a space, as compared with the field of view, about an inch in length. There was little or no orange, chiefly green and blue, and some red and crimson. The line of demarcation between the colours was most distinct. But the whole spectrum seemed to be more or less divided by darker lines or very narrow bands, perhaps not black, but a darker shade of the same colour; but they did not last longer than the prismatic colours as a whole.





I cannot say that the bands or lines *a*, *b*, *c* were at regular or irregular distances; nor could they be termed fine black lines; it gave, however, the appearance of simple interruptions, not noticed in the other two cases. Immediately the spectrum began to vanish,



I thought I perceived for an instant an orange streak just between the green and red, at *o*, which was most definite at the moment the other colours were vanishing; it was only for an instant, and did not go fairly down across to the lower border of the spectrum. The effect was peculiar and different to any other spectrum-appearance I have seen.

Rev. W. Sidgreaves, Stonyhurst College, Whalley.

I was particularly anxious to obtain some fairly reliable observations of time, altitude, and azimuth of some of the more brilliant meteors. But the state of the weather rendered this impossible. The night (12–13th) was hopelessly wet and dark all through. A succession of heavy hail- and rain-storms passed over during the night 13–14th, allowing occasional glimpses of the heavens. Nothing on this evening was seen before midnight, beyond occasional illuminations as if from distant flashes of lightning.

I was called a little after midnight; and from this till a little before 1^h A.M. (whilst preparing for careful observations during the hour from 1 to 2 o'clock) I looked out occasionally, and each time counted seven or eight meteors in the space of a minute and a half on the portion of the heavens comprised between the zenith and the south and east points. The sky was suddenly clouded over a little before 1 o'clock, and we had no break till 2 o'clock, when I gave up all idea of attempting to determine positions, and confined our attention to the simple occupation of "counting." From 2^h to $2^h\,15^m$, three of us, dividing the heavens between us, counted altogether eighty-two meteors, mean amount of cloud being rather more than 7. From $2^h\,15^m$ to $2^h\,30^m$, sky rapidly clouding over, we counted fourteen, mean amount of cloud about 9 (an overcast sky being represented by 10). From this time till $3^h\,40^m$ we had heavy rain, hail, and wind from west. From $3^h\,40^m$ to $4^h\,15^m$ we counted thirty-seven meteors, amount of cloud about 0·8, when another heavy storm obscured everything till $5^h\,45^m$. Between $5^h\,45^m$ and 6^h A.M., with a clear zenith for about seven minutes, amount of cloud rather less than 5, and arranged on the horizon, I counted only five meteors.

About one-third of the meteors seen were similar to Venus at its brightest, with brilliant unbroken trains varying between 20° and 30° in extent. Occasionally these trains seemed to disappear for a moment, and reappear in the same position. We could not be *sure* that this last phenomenon was not the effect of rapidly passing clouds.

At 3^h 47^m A.M., Greenwich mean time, a very brilliant bright pale-blue meteor crossed from a point between γ and ζ Leonis to a point very near to η Ursæ Majoris. The diameter of its ball was about a quarter moon's diameter. Portions of its train were seen through openings in the clouds for twelve or fifteen seconds after the disappearance of the ball.

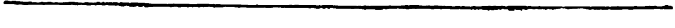
Another meteor about the same size started from between Orion's Belt and Sword, and soon disappeared in the clouds. This was bright pale red. Both these meteors illuminated the clouds as a distant flash of lightning would have done.

It would be very difficult to draw any conclusions from the next-to-nothing of data obtained during so unfavourable a night. But the impression produced on my two companions and myself was that the number of meteors must have been gradually decreasing, from between midnight and 1^h A.M., as the morning advanced.

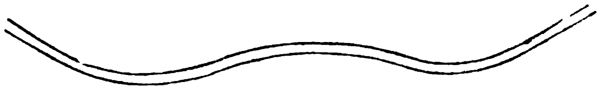
A very beautiful meteor was seen last evening (November 14) at about 6^h 45^m P.M., of which I will send some account as soon as I have been able to question those amongst the servants of the College who witnessed it.

C. W. MILLARD, Esq., Lowestoft.

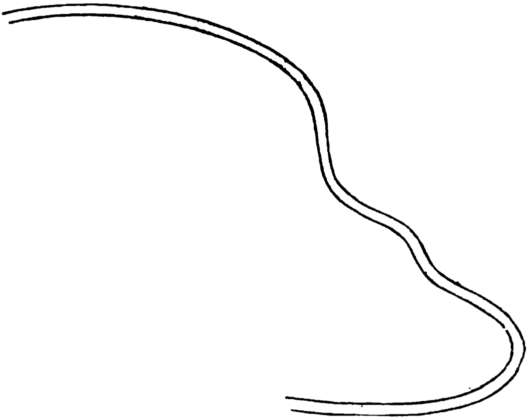
Having observed the meteors during the morning of Wednesday last at this place, and finding that many persons have published accounts of observations made by them, agreeing nearly with my own, I will trouble you with remarks upon only one meteor. It sprung from near the centre of Leo Minor, and disappeared near "Alioth" in the tail of the Great Bear, leaving behind it a streak of pale bluish light, which at first was of this form—



in a little time it became thus—



and in a minute or two afterwards something like this—



and at the expiration of about five minutes from my first seeing it vanished altogether.

It looked very much like a thin delicate line of smoke, gradually changing its form until it was lost sight of.

I viewed it through a large night-glass magnifying about six times.

I did not note the time, but believe it was soon after 1^h in the morning.

T. H. Waller, Esq., York.

The train of the last meteor in the list was at first straight, but soon became curved, and gradually gathered quite into a wisp, which plainly drifted, apparently pretty much in the direction of the wind.

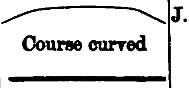
There was lightning at intervals all night, and several claps of thunder.

I forgot to say I saw one meteor, so far as I could judge, absolutely stationary.

Observations of

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Appearance; Train, if any, and its Duration.
1866.	h m					
Nov. 13	6 2½ P.M.	York ...	1½ mag.	Orange.........	½ second	....
	6 2¾ P.M.	„ ...	1½ mag.	Orange.........	½ second	....
	7 9½ P.M.	„ ...	1 mag.............	Yellow.........	¼ second	Disappeared in cloud.
	7 12 P.M.	„ ...	1⅓ mag.	Whitish	⅓ second	Disappeared in cloud.
	7 17 P.M.	„ ...	1 mag.............	Yellow.........	1 second	Short train.........
	7 19½ P.M.	„ ...	3 mag.............	Orange	¼ second	....
	7 35 P.M.	„ ...	2 mag.............	Light yellow	½ second	....
	7 43½ P.M.	„ ...	3 mag.............	Orange	¼ second	....
	7 48½ P.M.	„ ...	4 mag.............	Blue............	½ second	....
	7 54 P.M.	„ ...	4 mag.............	Yellow.........	½ second	....
	7 56½ P.M.	„ ...	2 mag.............	Yellow.........	½ second	....
	8 35 P.M.	„ ...	2 mag.............	Orange.........	¼ second	Very fast............
	9 18½ P.M.	„ ...	2 ♃ to 4 mag. ..	Light yellow	3½ seconds	Train green, gradually getting fainter and fainter, did not last long.
	9 34½ P.M.	„ ...	3 mag.............	Light yellow	½ second	Very slight tail ...
	9 35 P.M.	„ ...	4 mag.............	Light yellow	¾ second	....
	9 46½ P.M.	„ ...	1 mag.............	Orange	⅛ second	Slight tail ....
Nov. 14	2 40 50ˢ [A.M.	„ ...	+ ♃..............	Blue...........	1 second	Splendid train, first blue then orange.

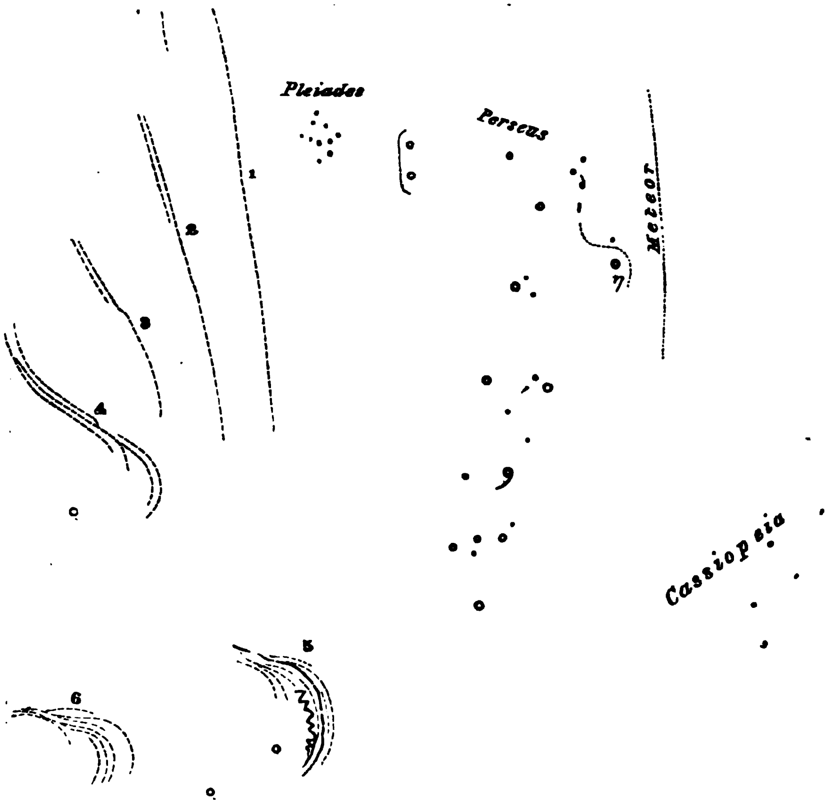
Luminous Meteors.

Length of Path.	Direction: noting also whether Horizontal, Perpendicular, or Inclined.	Position, or Altitude and Azimuth.	Remarks.	Observer.
....	Inclined 50° to horizon.	β Trianguli to α Muscæ.	....	S. Thompson.
....	75° to horizon ...	α Cassiopeiæ to cluster in Perseus.	....	„
....	Horizontal	α Aurigæ towards the north.	Disappeared in a cloud.	A. C. Marriage.
15°......	12° upwards	ο Aurigæ towards 19 Lyncis.	Disappeared in a cloud.	„
14°......	70° downwards ...	γ Aquarii to λ Aquarii.	....	„
5°	10° downwards ...	49 Cassiopeiæ towards α Ursæ Minoris.	....	F. Bewley.
....	70° downwards ...	12 Cassiopeiæ to λ Cassiopeiæ.	Nearly at zenith...	„
7°	....	σ Cassiopeiæ to ο Cephei.	Nearly at zenith...	S. Thompson.
....	65° downwards ...	β to δ Aquarii ...	....	J. E. Clark.
....	15° downwards ...	ξ Persei to α Aurigæ.	....	A. C. Marriage.
....	60° downwards ...	Near Polaris to β Ursæ Minoris.	....	F. Bewley.
....	75° inclined	Near Polaris to ζ Draconis.	....	J. E. Clark.
160° ...	N.E. to S., horizontal.	Bank of clouds close to Mars to κ Fornacis.	 Horizon.	J. E. Clark and R. G. Barclay.
....	Inclined ↘	μ Geminorum to very near α Orionis.	....	R. G. Barclay and J. E. Clark.
....	Inclined ↙	β Tauri to μ Geminorum.	....	R. G. Barclay.
....	Inclined	β Cygni to α Aquilæ.	....	R. G. Barclay and A. C. Marriage.
12°......	50° to horizon...... ↙	Ended 3° under α Cygni.	Train left; blown about by wind for seven minutes, afterwards hidden by a cloud.	T. H. Waller.

A. Batson, Esq., Ramsbury near Hungerford.

As you are probably localizing the November meteors, both in size and number, I send a sketch of one I observed on the memorable night (13–14th instant). Of all the accounts in the papers, I have seen none which give nearly so long a duration of the train, except those of Mr. Herschel at Glasgow.

Time about 1h 12m P.M., about 12° from zenith, direction nearly vertical to the west. Duration of the train from five to six minutes; it gradually curled up and drifted some degrees to the south as shown.



I could not see my watch very well; but, from my photographic practice, I am sure that the duration was quite five minutes (very white and brilliant at first); my sons agree with me as to time, &c.

Rev. G. Crompton, Norwich.

From 11^h 55^m to 12^h 20^m electric clouds were flying about from N.W. to E.S.E., and there was frequent lightning near the S.E. horizon, but no thunder.

At 12^h 55^m, the sky became overcast and sent us in; we went out again as soon as possible, as it partially cleared, and found the display much increased. At 12^h 4^m, Norwich time, I saw one meteor cross the foot of Ursa Major, which changed colour from bluish to red. It seemed as if they came in rushes, 3, 4, and 5 at a time, after short pauses. Several were visible through the fleecy electrical clouds. Many were beautiful, like balls; and nearly all left streaks of light, apparently, behind. Many were about 3 or 4 seconds in duration, especially those from Gemini towards Orion; but several flashed and vanished in much shorter time. It seemed as if we could mark out the path they would appear in, or could hang wires for them to run upon, so regularly did they pass in lines diverging from a point in Leo. I think we reckoned only 3 or 4 that seemed to fall in any other direction. We had no means or skill to take any observations as to their elevations. Those in the first hour were, in many cases, of a reddish colour; but when the sky was clearer, they appeared to be blue, white, green, and oftentimes red.

No one could see the singular rapidity of their flashing, or their uniform divergence from a point in Leo without being struck with a novel sensation of a singular operation going on in that part of the sky.

William Lawton, Esq., Hull.

Having observed the predicted display of the "November Meteors" under circumstances of weather unusually favourable, the following particulars may perhaps be interesting. I was informed on Tuesday, by a gentleman residing in Coltman Street, that he and his father, about three o'clock in the morning of that day, had witnessed, through openings in the clouds, a partial display of the phenomenon; and as his description of the direction and appearance of the shooting stars agreed with the accounts of previous observers, I felt confident that, with fine weather, those who took any interest in such events would not be disappointed.

As the constellation Leo, in which the radiant-point is situated, would not rise until near midnight, I had not intended to be on the look-out much before that hour; but in going home I observed, at 9^h 19^m, a bright meteor proceeding in a direction from between β Gemini and the planet Mars, in a slightly upward direction towards the constellation Taurus, then partially obscured by a cloud, behind which the meteor disappeared, and probably exploded, as the heavens in that neighbourhood were immediately afterwards illuminated by a white flash of light. As the direction of the meteor was in a line with the constellation Leo, not then visible above the horizon, I supposed it was probably the commencement of the phenomenon. At this time, however, and for the next hour, the sky was partially covered with clouds.

At 10^h 44^m I observed a flash due east among clouds, and at 10^h 47^m another. At 11^h 52^m there was one in the south. Now, although I saw lightning during the night, these several flashes of light were more circumscribed than sheet lightning usually is. My impression is that they were the explosions of meteors which the clouds had prevented being seen. At 11^h 6^m I caught a glimpse of a rather bright one in the E.S.E., descending towards Leo, and immediately another in the south, at an elevation of about 25°; and almost at the same time one also in the south, at an elevation of about 70°. The course of both these was from east to west, and both left luminous trains behind them. At 11^h 26^m a rather bright one appeared due south, its course being from east to west, slightly downwards, and at a mean altitude of Rigel. From 11^h 30^m to near 12^h I noted about twenty in various parts of the sky, but none of these were of any brilliancy. As midnight approached, and whilst the hour of 12 was striking, a marked increase took place both in their number and brightness. At 11^h 59^m a bright one passed from Leo towards Mars. Whilst the hour was striking, several appeared, all radiating from a point near γ Leonis; one, very bright, passed just below the planet Mars. At 12^h 3^m a very brilliant one appeared in Leo, but its course was short. At the same moment several more appeared, all radiating from the same point. At 12^h 6^m two passed beneath Sirius; others from Leo passed above and below the constellation of Ursa Major, followed by a very bright one at a lower altitude. These were succeeded by two others, one of a beautiful blue colour, the other of a deep orange. Almost at the same time one appeared in the south, another in the east; whilst a spectator reported two traversing the north-east. At 12^h 14^m three were seen in different parts of the heavens, one in the west. At 12ʰ 18ᵐ five were visible, including two in Ursa Major and one in the west. At 12ʰ 20ᵐ three passed through the northern part of Orion, another through the belt of the same constellation, and another through the Pleiades. At 12ʰ 22ᵐ a bright one passed to the south of Orion. At 12ʰ 24ᵐ one, with a bright blue train, appeared in Ursa Major continuing its course to Ursa Minor.

12ʰ 25ᵐ. At this moment the flight was continuous, particularly from near the radiant-point, through Ursa Major to Ursa Minor; frequently two were seen racing close together in courses parallel to each other, or slightly divergent. At 12ʰ 30ᵐ a large one crossed the zenith. During the next ten minutes they were very numerous, as the following extracts from my note-book show:—"12ʰ 31ᵐ, six nearly together. 12ʰ 33ᵐ, several leaving blue trains and having blue or orange nuclei. One crossed to the north. This appeared on the zenith, and after traversing the border of Ursa Minor, burst near the northern horizon; its course was therefore at right angles to the majority of the others. At 12ʰ 34ᵐ three were seen in the west, one very bright. At 12ʰ 36ᵐ a brilliant flash of sheet lightning illumined the whole of the western sky. At 12ʰ 39ᵐ there were very numerous and brilliant ones, passing from east to west, right across Sirius." At 12ʰ 41ᵐ a large and splendid one appeared in the constellation Leo, from whence it progressed towards Mars, and exploded about five degrees to the south of that planet; its nucleus was oval, the line of its major diameter being horizontal, the minor or vertical diameter appearing about one-fourth the diameter of the moon; the colour of its large and brilliant train was pale blue, that of the nucleus appeared cadmium yellow; the residue of the meteor remained visible and stationary for several seconds after its explosion. This was the largest and most brilliant that I observed during the whole night, except in the length of its course, which was comparatively short.

At 12ʰ 52ᵐ a very bright one passed about one degree to the north of Aldebaran.

At 12ʰ 58ᵐ, there being several spectators present, it was proposed that four persons should respectively face east, west, north, and south, and silently count the number of meteors that appeared in their respective quarters in the course of one minute, the time being accurately given by my watch. This proposal was readily adopted, with the following result:—

	Number.
East	36
South	32
West	25
North	34
	127

This gives at the rate of 7620 for the hour, supposing them to have been as numerous throughout its duration, which was not the case.

At $1^h\ 3^m$ a continuous stream was passing from near the radiant-point through Ursa Major and Orion.

At $1^h\ 5^m$ a second counting party was formed, but consisting of eight persons, so as to take the intermediate points, S.E., S.W., &c., as well as the cardinals, when the result was as follows:—

	With Eight Observers.	With Four Observers.
East	32 ...	32
South-east	21 ...	0
South	44 ...	44
South-west	18 ...	0
West	33 ...	33
North-west	43 ...	0
North	22 ...	22
North-east	42 ...	0
	255	131

Now it is probable that in this instance those meteors which had long courses, and passed from east to south, would be counted twice or even thrice; therefore I give this result with reserve, although there is no doubt the display was at its maximum between 1^h and $1^h\ 30^m$. At $1^h\ 10^m$ the numbers were again taken by a party of four, as in the first instance, with the following result:—

North	47	...again at $1^h\ 17^m$...	North	24
East	49	,, ,,	East	40
South	39	,, ,,	South	34
West	47	,, ,,	West	37
	182			135

If the mean of the four numerations are taken we have the following results:—

h	m	Number.
12	58	127
1	5	131
1	10	182
1	17	135
	Sum =	575

or 30·2 per minute for the 19 minutes from $12^h\ 58^m$ to $1^h\ 17^m$. After $1^h\ 30^m$ the meteors diminished in numbers, but rather increased in individual brilliancy, as the subsequent counting at

1ʰ 45ᵐ, by two of us looking north and south, indicates:—South 14, north 11=25.

At 1ʰ 52ᵐ a very fine one crossed the northern heavens, at an altitude of about 20°, and immediately afterwards another, of a reddish colour, descended due west.

At 2 o'clock I returned home from the Corporation Pier, which I had chosen as the best site for an extended view of the whole heavens, and also for enabling me by one of the lamps to read the times, which, in observations of conspicuous meteors, should always be done by every observer, and their paths amongst the stars carefully noted.

Query.—As there were two showers in North America, namely, 1833 and 1834, may we expect to see another next November?

[There was a shower in 1865, but it is very probable that there will be one in the year 1867, and arrangements must be made to observe it.—Ed.]

M. P. Moyle, Esq., Helston, Cornwall.

A few minutes before midnight, on the 13th, one appeared from the south-east, and darted towards the earth in an easterly direction; and when within a few degrees of the horizon burst with an evident report, like the explosion of a sky-rocket. Soon after this there was a constant stream of meteors, apparently issuing from Leo as a centre, and radiating from thence to the west and south-west, principally the latter; they succeeded each other with such rapidity that it was impossible to time them. They nearly all bore a long train of a dull red colour; one I observed to be of a bright orange, the nucleus of which was most brilliant white. I counted 276 in the space of half an hour, when I gave up numbering them.

About 1ʰ 30ᵐ A.M. (14th) four issued at once, and pursued their course south-west, perfectly parallel to each other, and at the apparent distance from each other of only a few feet, and they all passed the belt of Orion before they disappeared. Two were very bright white, the other two were red. Many hundreds passed until 2ʰ 15ᵐ A.M., when I discontinued my observations. The undercurrent of wind was north-west; a few dim clouds passed occasionally, the edges of which were illuminated as from a flash of lightning whenever a meteor passed behind it.

Professor Grant, Glasgow.

The expected shower of meteors was observed here last night, or rather this morning, under eminently favourable circumstances. Besides myself and the two assistants who were prepared to watch the phenomenon, Mr. Herschel joined us from Glasgow about midnight; so that we constituted in all a small corps of four observers. The early part of the night did not promise well, heavy clouds and drenching showers of rain alternating with clear views of the sky and the stars. In the latter intervals an occasional shooting star might be seen, but the number of such objects was inconsiderable. About midnight the constellation Leo had ascended in the east above the horizon, and as the point of emanation of the meteors is situated in this constellation, it might have been expected that henceforward the phenomenon would assume a more prominent aspect. Between midnight and 1 o'clock the sky on the whole was not favourable for observation, but occasional views of the heavens showed unmistakeably that we were upon the track of the meteoric shower, for the meteors were obviously shooting athwart the sky with increasing frequency. Shortly after 1 o'clock the heavens everywhere became beautifully clear, and we had the good fortune to obtain henceforward a magnificent and uninterrupted view of the phenomenon. At $1^h\ 15^m$ the heavens had assumed an extremely imposing aspect. Multitudes of beautiful meteors were now everywhere visible, but especially in the eastern regions of the heavens, where the constellation Leo was to be seen as he gradually ascended in his course towards the meridian. Hundreds of the meteors far surpassed in brilliancy the stars of the first magnitude. In multitudes of instances they were brighter than Jupiter, and some of them even equalled Venus when she is in her greatest brilliancy. Their prevailing colour was white, but some had a yellowish tinge of light, while others had a bluish tinge. In every instance they were accompanied by a straight narrow train of well-defined light, of a beautiful emerald-green colour. The length of the train varied much for the different meteors. Many of them extended over an arc of 30°, 40°, or 50°, and some were even of still greater length. As stated, they were almost without exception straight in the direction of their length, and their courses among the stars presented clear indications of the emanation of the meteors from a common region of the heavens situated somewhere in the constellation Leo. The meteor in every case first presented itself to observation, and then as it pursued its course westward through the heavens it was seen spinning out its beautiful train of green light. In general the meteor and its train were visible for about three or four seconds, but in some instances they continued in view as long as five seconds. At $1^h\ 18^m$ a whole group of brilliant meteors was seen to burst out and diverge like a fan from the radiant-point in Leo. The appearance which the heavens everywhere now presented can only be compared to the effect produced by the general discharge of a vast number of rockets. At $1^h\ 20^m$ I counted the number of meteors visible in one minute, and I found them to amount to fifty-seven; but this in all probability did not exceed one-third of the number really visible in every part of the heavens. Shortly afterwards it became evident that the earth had passed through the thickest of the shower. At $1^h\ 30^m$ the number of meteors counted in a minute amounted to thirty. At $1^h\ 35^m$ the number counted in two minutes amounted to forty-three, or twenty-two in a minute. At $2^h\ 4^m$ the number counted in a minute amounted to only thirteen. At $2^h\ 42^m$ the most remarkable phenomenon of this kind presented itself to us in the constellation of Ursa Major, but unfortunately none of us caught the commencement of it. The blaze of light which this meteor emitted at the time of vanishing was extraordinary. It left behind it a curved residue of faint light of sensible breadth, and having the form of a horseshoe, the extremities of which at first embraced ϵ and γ Ursæ Majoris; but as it gradually grew fainter it expanded in dimensions, until ultimately before vanishing one extremity embraced ϵ Ursæ Majoris, while the other extremity reached as far as α and β of the same constellation (the two pointers). This singular phenomenon continued visible in the heavens for 20 minutes after it first attracted our attention. At 3^h the number of meteors visible in a minute had diminished to two or three. At $4^h\ 30^m$ only one meteor was visible every two or three minutes. At 5^h the starry heavens might be said to have assumed their normal aspect, and our task as observers of this magnificent phenomenon was now clearly ended. It was obvious that the earth had passed through the main part of the meteoric shower between the hours of 1 and 2 o'clock. The diminution of the number of meteors visible in the heavens subsequently to this occurrence was rapid and palpable. In tracing the course of the meteors among the stars we were eminently favoured by the section of the celestial sphere which happened to be above the horizon at the time of our observations. The splendid constellation of Orion was on the meridian, and the brighter of its stars, with Capella, Procyon, Aldebaran, Sirius, Castor, Pollux, &c., formed a series of admirable points of reference for ascertaining the precise region of the heavens whence the meteors were emanating. This point of emanation is situated not far from the bright star γ Leonis. It might be remarked that the constellation Leo indicates the region of the heavens in the direction of which the earth is at present travelling by virtue of its annual motion round the sun.

The records of history, both ancient and modern, contain some very interesting accounts of the apparition of showers of meteors in the heavens. It is mentioned, for instance, by a writer that on the 13th of October, 902 A.D., "there were seen as it were lances, an infinite number of stars, which scattered themselves like rain to the right and left; and that year was called the year of stars." Coming down to a more recent period, we find an interesting account by Humboldt of a shower of meteors which he witnessed in South America on the 13th of November, 1799:—"Towards the morning of the 13th," says he, "we witnessed a most extraordinary scene of shooting meteors. Thousands of falling stars succeeded each other during a period of four hours. Their direction was very regular from north to south. From the beginning of the phenomenon there was not a space in the firmament equal in extent to three diameters of the moon which was not filled every instant with bodies of falling stars. All the meteors left luminous traces of phosphorescent bands behind them, which lasted seven or eight seconds." On the 13th of November, 1833, there occurred an immense shower of meteors, which was visible throughout North America, and respecting which there are to be found some interesting accounts. The regular occurrence of these phenomena at the same time of the year has suggested the theory of the sun being encompassed by a ring of meteors revolving round that body in the vicinity of the earth's orbit. This theory is supported by the result of recent researches in physical astronomy, which indicate the existence of a perturbative influence of small amount, but proceeding from some unknown source, exercised upon the movements of the planets Mars and Venus. Professor Newton, of Newhaven, in America, upon comparing together the records of the November shower of meteors, has concluded that in a period of 33¼ years the meteors appear in unusually immense numbers; and he was thus led to predict that on the 13th of November in the present year one of such extraordinary displays would occur. Assuredly the result of last night's observations tends to confirm the existence of such a period. Professor Newton supposes the meteors to have a retrograde motion, and that the ring which they constitute is inclined to the ecliptic at an angle of about 17°.

The November meteors are bodies, in all probability, analogous to the small planets which revolve round the sun between the orbits of Mars and Jupiter, and to the meteors which physical astronomy indicates as probably revolving round the same body within the orbit of Mercury. Meteors, like comets, may be said to be indefinitely great in number, although the aggregate mass of those which revolve in the vicinity of the hitherto discovered bodies of the planetary system must necessarily be small. What purpose they serve in the economy of creation it is difficult to discover; but that their existence is connected with some important operations of nature is a conclusion which must occur to every thoughtful mind.

It may be mentioned that the average height of the meteors above the earth's surface has been found to be about seventy miles.

A. Forbes, Esq., Culloden, Inverness-shire.

The predicted shower of meteors was seen here to great advantage. Between 11ʰ 57ᵐ P.M. on the 13th (Greenwich mean time) and 0ʰ 31ᵐ 30ˢ A.M. of the 14th upwards of 50 meteors were counted; but the grand display did not take place until 1ʰ 5ᵐ A.M., when meteors, varying in size from Venus and Jupiter to stars of the third magnitude, fell in such numbers, until 1ʰ 32ᵐ, that it was impossible to count them. They shot forth from nearly all parts of the sky, but by far the greater number appeared to emanate from Leo Minor. Their general course was across the zenith in almost a due westerly direction; and down to the western horizon many were constantly descending that seemed to originate between the constellations Andromeda and Cassiopeia, and from Perseus and Gemini. The light emitted by the largest meteors was very beautiful, being occasionally tinged with prismatic colours; but for the most part they were white in hue, and so bright that considerable reflection was cast on dark objects around. I distinctly heard a crackling noise from several of the meteors as they passed, which occurred when the nucleus exploded or became extinguished, exactly resembling the crackling of dry whins or thorns when thrown into the fire; but one of the larger meteors observed by Mrs. Forbes exploded with a report equal to a pistol-shot. This meteor was seen by her at 0ʰ 3ᵐ A.M.; it shot upwards in a conical form from over the W.S.W. horizon, passing near the star "*Menkar*" in Cetus. Trains of whitish light, of from 3° to 10° and

15°, were left behind many of the brighter meteors, remaining visible for from 5 to 20 seconds; but one, in particular, was in this respect very remarkable; it shot down from between Cassiopeia and Perseus into Andromeda, where it became extinguished, leaving a train of whitish light fully 15° in length, which continued visible for upwards of 3 minutes. The stream, or train of light, remained for more than a minute in the line through which the nucleus had passed; it then became diverged in the centre, as if by a cross current of air, towards the right, then curved upwards into a ball in Andromeda, and began to move to the left, or across the constellation in a S.S.E. direction. The maximum of the *shower* was between 1^h 10^m and 1^h 20^m A.M.; and after 1^h 32^m the meteors rapidly declined in number, and by 5^h A.M. none could be detected. At 0^h 41^m A.M. there was a flash of "sheet" lightning, and another at 3^h A.M. Faint aurora in the earlier part of the night was visible over the northern horizon. A brisk west wind prevailed till morning, blowing with a force of from 2 to 4 lb. pressure. The average amount of cloud was from 4 to 6, but there were occasional showers of rain mingled with sleet, which entirely obscured the sky and interrupted observation. The lowest temperature during the night of the 13th was 36°·3, and the barometer rapidly rose from 29.129 in. (corrected) to 29.571 in.

I may mention that several meteors were observed on the night of the 12th and also earlier in the month.

Lieut. Rikatcheff, Imp. R. N., St. Petersburg.

I send you my observations of meteors on the nights of 12th and 13th of November, 1866. The day of the November shower approaching, I intended to make observations during four nights, 11th to 14th. For exact determination of time of appearance and disappearance of meteors I used a chronometer, which was compared with the normal clock at the Imperial Academic Observatory. Professor Lavitch kindly took transit observations on the 11th November for giving me exact time. The night was clear, and I began the observations about 6^h 45^m P.M. on the 11th November. From 8^h to 9^h 15^m I went down. And from 9^h 15^m P.M. to 2^h A.M. on the 12th, I was again looking for meteors from the Observatory of Navy Cadets' Corps. The cold (about 20° temperature) and windy weather obliged me to come every half hour down into the room.

Register of Luminous Meteors observed at St. Petersburg (lat. 59° 56′, long. 2^h 1^m 13^s·5 E.) on the 12th and 13th of November, 1866, Observatory of the Navy Cadets' Corps.

Meteor.	St. Petersburg; Mean Solar Time of the Appearance of Meteor.	Duration.	Apparent Size.	Colour.	Appearance; Train, if any, its Duration.	Remarks.
No.	d h m s	s				
1.	Nov. 11 6 52 14 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking about 15 minutes towards E., and occasionally on other parts of the horizon.
2.	7 5 14 P.M.	2·0	2<Venus	Yellow...	No train.	
3.	7 14 4 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking about 15 minutes towards S., &c.
4.	7 14 29 P.M.	2·5	2<Venus	Blue......	With train; about 0^s·5	
5.	7 28 28 P.M.	0·5	3rd mag. *	White ...	No train.	
6.	7 44 17 P.M.	1·5	2nd mag. *	White ...	No train ...	Looking about 15 minutes towards W., &c.
7.	7 55 4 P.M.	1·8	2nd mag. *	White ...	No train.	
8.	9 32 41 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking about 15 minutes towards N., &c.
9.	9 42 0 P.M.	0·5	2nd mag. *	White ...	No train.	
10.	11 18 57 P.M.	0·8	2nd mag. *	White ...	No train ...	From 10^h P.M. to 10^h 40^m P.M., saw no meteors on the E.
11.	11 28 6 P.M.	0·5	3rd mag. *	White ...	No train.	
12.	11 31 47 P.M.	0·8	2nd mag. *	White ...	No train.	
13.	11 52 51 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking towards S. about 40 mins. &c.
14.	Nov. 12 0 26 36 A.M.	0·8	2nd mag. *	White ...	No train ...	Looking towards W. about 40 minutes &c.
15.	0 35 3 A.M.	0·8	2nd mag. *	White ...	No train.	
16.	0 51 26 A.M.	1·0	2nd mag. *	White ...	With train; about 0^s·1	
17.	1 33 18 A.M.	1·5	1st mag. *	White ...	No train ...	Looking towards N. about 40 minutes, and occasionally towards other parts of the horizon.
18.	1 40 23 A.M.	1·5	1st mag. *	White ...	With train; about 0^s·3	
19.	1 45 13 A.M.	0·8	2nd mag. *	White ...	No train.	
20.	1 56 10 A.M.	0·8	2nd mag. *	White ...	No train.	
21.	2 4 0 A.M.	0·8	2nd mag. *	White ...	No train.	
22.	9 40 42 P.M.	1·5	Sirius	White ...	With train; 0^s·3.	Looking E. about ½ hour.
23.	10 53 4 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking S. about ½ hour.
24.	11 39 42 P.M.	0·8	2nd mag. *	White ...	No train ...	Looking W. about ½ hour.
25.	11 43 4 P.M.	1·0	2nd mag. *	White ...	No train ...	For the meteor No. 24 no exact position was determined.
26.	Nov. 13 0 2 8 A.M.	0·8	2nd mag. *	White ...	No train ...	There were clouds on the N.
27.	0 2 52 A.M.	0·8	2nd mag. *	White ...	No train.	
28.	0 7 0 A.M.	0·8	2nd mag. *	White ...	No train ...	Looking on all parts where the stars were visible; no exact time was determined of the meteor No. 28.
29.	0 10 6 A.M.	0·5	3rd mag. *	White ...	No train.	

Observer M. Rikatcheff.

On the 12th it was cloudy till 10^h P.M., and nearly clear from that time to 0^h 30^m A.M. on the 13th. I remained on the Observatory till 1^h 30^m A.M., and as the sky all this time was cloudy I returned home. The nights of the 13–14th were cloudy. The register I send you gives the number of meteors, the mean solar (St. Petersburg) time of appearance of each meteor, its duration, apparent size, colour, and remarks about trains, if any, and other remarks. The position of the meteors at their appearance and disappearance and their directions may be seen from the subjoined map; a few days before, I brought the attention of the public to the expected shower of meteors on the 11–14th November, and I mentioned that the British Association appointed a Committee annually for their investigation.

Herr SCHMIDT, Athens. Translated by W. T. LYNN, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich.

The meteoric shower of the 13–14th of November, 1866, was well observed by Herr Schmidt, the Director of the Observatory at Athens. A short notice of his observations was sent to the Astronomische Nachrichten, to M. Le Verrier, to Mr. Birt, and to an Athenian paper called the Αἰών ('Age'), and a longer one to Professor Heis, of Münster. But the fullest report was written to Herr Haidinger, and by him communicated to the Vienna Academy of Sciences. From that communication, at the request of Mr. Glaisher, who has kindly placed a copy of it in my hands, I have made the following summary.

In consequence of a misunderstanding in the distribution of labour with his assistants, a part of the night was missed by Herr Schmidt. One assistant observed until 14^h; Schmidt himself and two others commenced at 16^h: but he thinks the loss cannot seriously affect the results arrived at.

For some years past he has employed three persons (who are not otherwise engaged in scientific observations, and whom he calls A, B, C) to determine the hourly number of meteors (called z for one observer) visible on moonless nights. S denotes Schmidt's own observations. A and B very nearly agreed with him in number, but C, an old and infirm man, usually only observed about half.

On the 13th of November, from 6^h to 12^h, nothing remarkable appeared. S observed until 8^h at the Observatory, and then until 11^h on the terrace at his house, but few meteors being visible.

On returning to the same place at 16^h, the number (of all magnitudes) was extraordinary, and although the usual comparisons to a shower of rain or snow were inadmissible, yet they surpassed the ordinary means of counting. The eye was repeatedly attracted by the number which flew in parallel directions through Canis Major, Orion, and Hydra. Not less striking was the number of greater phenomena, called by Schmidt bolides or fire-balls when their brightness exceeds that of Sirius. For not only from three to five of these often flew close together within a few seconds, but slow green streaks also frequently arrested attention, indicating meteors concealed behind the neighbouring mountains, or those in a different part of the sky to that at which the observer was at the moment looking; these were clearly distinguishable from lightning by their colour, considerable duration, and non-vibratory light. But few meteors of the first order or even second (notably brighter than Venus) were seen. Only one, indeed, of the first was seen by Schmidt, which bore comparison with the great Athenian meteor of the 18th of October, 1863. Many, however, appeared of the brightness of Sirius, Venus, and Jupiter, tailed-bolides, green and yellow.

One moment (about 16^h) sufficed to show that the radiant-point was in Leo; but Schmidt did not determine it very accurately, contenting himself with noting that it was between γ and ϵ Leonis. From 16^h to 18^h, of all the meteors he saw, there were only two small shooting stars, which certainly did not radiate from near there.

Soon after 16^h the number began to diminish. At the most favourable time, the rate gave $z=$ about 1000*, and amongst them 80 or 100 bolides.

At 16^h 18^m nearly all the stars were obscured by a magnificent meteor of the first order, which lighted the whole town and landscape as if with Bengal-fire. The dazzling curved tail was observed with a comet-seeker magnifying eight times, showing the ordinary appearances in its great extent of 10° long and $\frac{1}{4}$° broad. After five minutes it lost itself in some red-yellow cloud. To the naked eye the tail looked like a great reddish patch of cumulus cloud as if lighted by the moon, and was between the two Bears. It continued visible, slowly diminishing in light, for at least fifty-one minutes, till it faded away in the morning twilight. Several other meteor-tails remained visible for from five to fifteen minutes; and some tails were seen in the sky whose meteors had not been

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* That is, for the mean of each observer: Schmidt himself, in the most favourable position, found z at a maximum = about 1800.

It has occurred to me that the phenomena may be due to another cause, and I now venture to publish the theory, together with some reasons in support of it, in order to attract the notice of those who have made meteors their particular study.

We know that when air is suddenly compressed it not only gives out heat, but it also exhibits *light*. As a familiar instance of this I may adduce the philosopher's tinder-box, which consists of a glass cylinder, closed at the end, and fitted with a piston, which on being forced in, compresses the air and causes it to yield up sufficient of its latent heat to ignite German tinder, and at the same time produces a flash of light.

My theory respecting the meteor is, therefore, this:—The meteor compresses the air, sets it in vibratory motion, and produces light from it (and this light remains, marking the meteor's track, until the exciting cause has ceased and the air regained its equilibrium); but whether the light produced is regarded as the latent heat of the air, developed at an incandescent temperature, or as another phase of the undulatory theory of light, it is not supposed that combustion takes place, either of the meteor or anything else. Indeed, it would seem that combustion could not occur under the circumstances. For instance, the combustion of a substance can only go on when the supply of air is not too great to cool the substance below the heat which oxygen requires to combine with it in the form of combustion; and we know that, if the volume of air is increased beyond this, combustion will cease, or, as we say, be blown out.

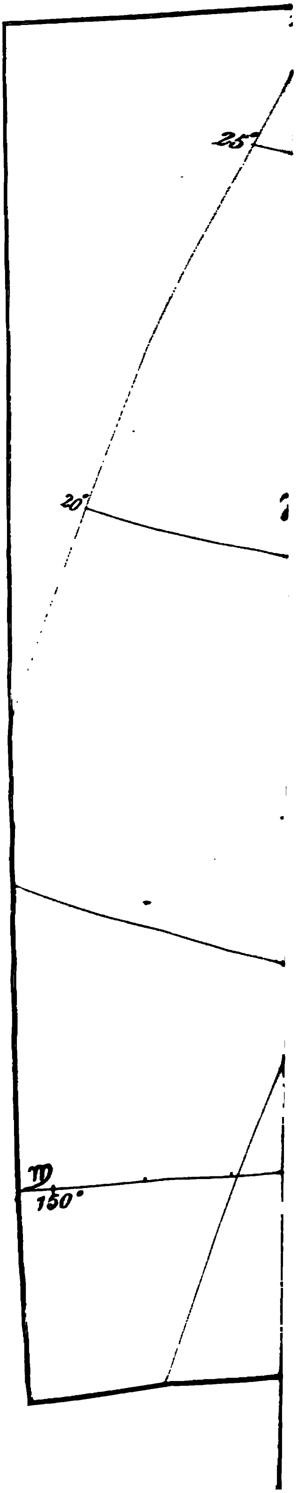
Now taking into account the velocity at which meteors move the volume of air they come in contact with, and the high capacity which rarefied air has for heat, it would appear that, if a meteor came flaming into the atmosphere, it would be instantly extinguished.

Supposing the meteors, therefore, to have sufficient cohesion to resist being broken up by the force with which they encounter the air, there seems reason to believe that they pass through the ordeal with little or no change in their physical structure.

And, in conclusion, I submit that the theory which allows meteors thus to escape, accords better with the general order and perpetuity which distinguish astronomical bodies, than the theory which supposes that thousands of ponderable bodies, moving in orbits of their own, are individually annihilated in the short period of a terrestrial night.

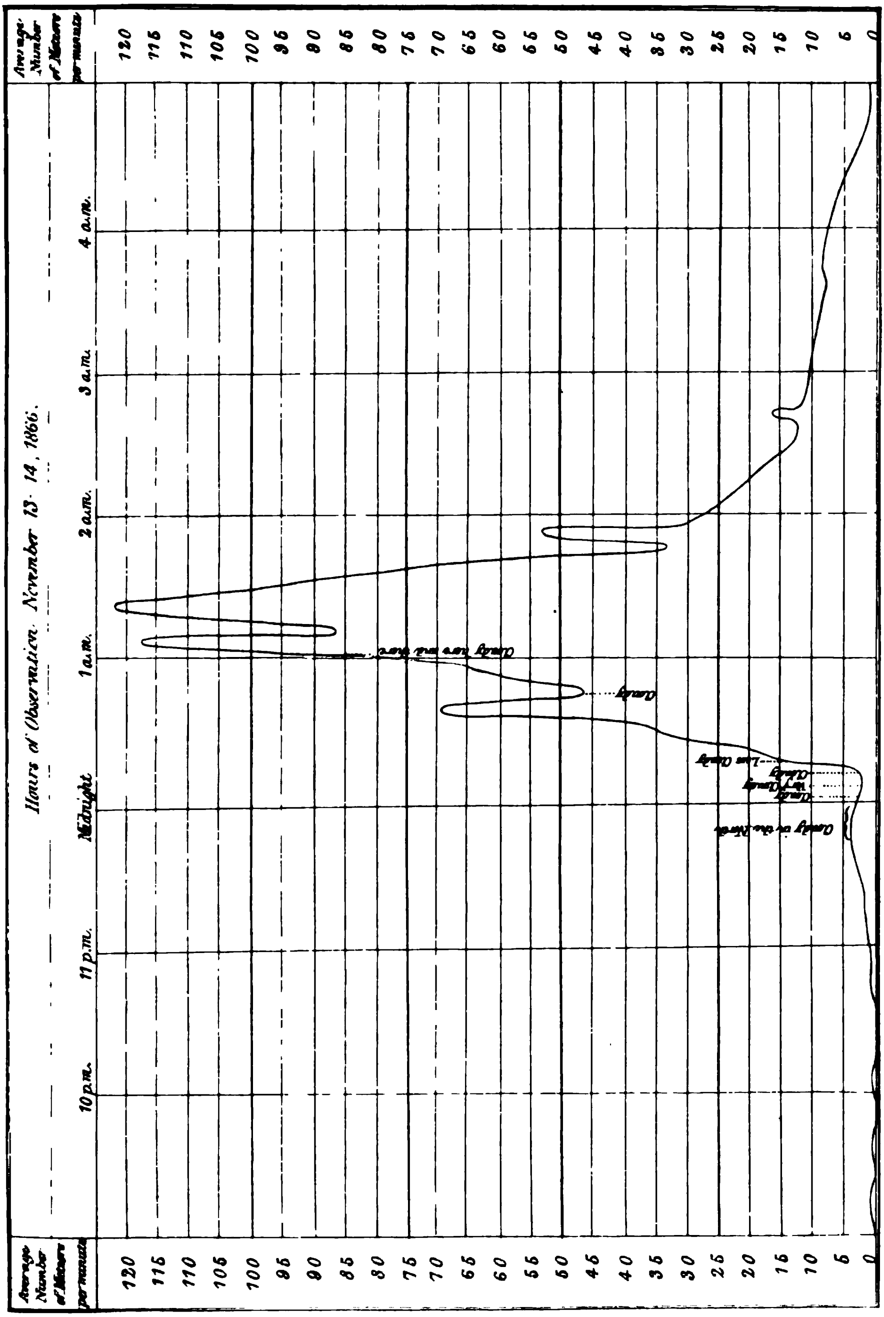
E. T. LOSEBY.

Leicester, 24th Nov., 1866.



25°
20°
♍
150°

DIAGRAM SHOWING THE AVERAGES PER MINUTE OF NUMBER OF METEORS
AS OBSERVED AT THE ROYAL OBSERVATORY GREENWICH, ON NOVEMBER 13–14, 1866.



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PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

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C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

A. Mercer Adam, Esq., M.D., Bargate Lodge, Boston, Lincolnshire;
Frederick Bernard Dœring, Esq., 27 Duke Street, Piccadilly;
John Marshall, Esq., Merridale Road, Wolverhampton;
H. E. Segrave, Esq., 21 Dorset Square, W.;

were balloted for and duly elected Fellows of the Society.

The names of Four Candidates for admission into the Society were read.

CXXX. *Terrestrial Magnetism.*

By John C. Bloxam, Esq., F.M.S.

That the magnetism of the earth results from other meteorological actions, perhaps few will be disposed to doubt; but what the actions are that the magnetism depends upon, or what other conditions it is connected with, we at present know very little about. The subject calls for inquiry, and possibly such indications as have been obtained from the St.-Helena record of observations may be deserving of consideration.

One great difficulty in analyzing magnetical observations consists in the great irregularity that obtains in the progression of magnetic phenomena, this causing great obscurity as to the dates of culmination and the periods of high and low values. This renders it necessary to reduce many observed values to one mean quantity for one time-category, and, further, to combine these meaned values by some efficient as well as correct smoothing process, so as to get successive *group-values* from the series of mean quantities. The horizontal force was the magnetic particular selected for the investigation. Daily values for the horizontal force were first obtained by summing together the daily means entered in the St.-Helena Tables for the two years 1842 and 1843. Forty-eight observations contributed to each of these aggregate values, because each daily mean of each year was the mean of twenty-four hourly observations. A complete set of twofold mean daily values for the year having been obtained, these mean values were then corrected for the temperature of the barometer. The corrections for this purpose were collected from the bar. temperature Tables reduced in the same way. These *corrected* mean daily values were then smoothed by the process I have already referred to in other communications. This produced the ultimate adopted values; but the two *additional* decimals obtained by the smoothing reduction were discarded. Each of these adopted daily values may be said to give the true indicatory value of 912 observations, because (the smoothing process having been twice effected) the day immediately concerned, the nine days next preceding it, and the nine days succeeding it, each contributes to the one adopted value, and each of these nineteen days has the proper weight of forty-eight observations. These ultimate normal values form Table I. The St.-Helena values for atmospheric temperature, for the same two years, were combined and reduced in the same way that those for the other two particulars were. The maximum, minimum, and mean values obtained for temperature are given, together with their respective dates, in Table II. The mean values for the months, for horizontal force, are given in Table III.: the first column in this Table gives the sums of the columns in Table I., the second column gives the mean values of the sums, the third column is introduced merely for the purpose of simplifying the mean values by omitting the decimals. Table IV. gives the several maxima and minima (or salient values) for horizontal force in the order of their occurrence through the year. Table V. gives the several dates on which the annual mean for horizontal force occurs in the course of the year, 136 being taken as the mean.

These Tables show at once that the variations in the intensity of horizontal force do *not* correspond with the variations in temperature. The annual progression of the one particular does not at all keep pace with that of the other, whether we look to the St.-Helena temperatures (as southern temperatures or as intertropical) or to the Greenwich (northern) temperatures. Looking to the extreme values, the maximum for horizontal force falls on July 29, and at St. Helena the maximum for temperature falls on February 26. The minimum for horizontal force falls on December 10, and the minimum for temperature at St. Helena on August 14. These dates for the extreme values for horizontal force do not diverge so much from those for the extremes of temperature *at Greenwich*. Maximum temperature occurs at Greenwich on August 2 and 3, the minimum on January 9; the value for December 10 is as much as 4°·8 above the minimum. Then high values for horizontal force, which are but little below the maximum of July 29, occur on March 27 and on April 28; and low values, but little above the minimum of December 10, occur on July 5 and on October 28. Further, the annual mean for horizontal force recurs frequently in the course of the year. It is thus made clear that the variations in intensity are not caused by any influence which observes such periods of increase and decrease as temperature does. The variations were of such a nature as to suggest dependence on hygrometric changes. May they not depend on the transitions that occur between the solid, liquid, and vaporous states of the aqueous element? If the affirmative should be established, it would follow that the magnetic condition itself must be caused by these transitions. We must look to the *relative* hygrometric conditions of different regions of the earth for the explanation of the magnetic phenomena. Active evaporation in one hemisphere and active condensation in the opposite hemisphere would each intensify the horizontal force. The southern hemisphere may be regarded as a region of evaporation, owing to the great extent of sea and small extent of land there; and the northern hemisphere must be relatively a region of condensation, owing to the great extent of land and the small extent of sea there. And, in consequence of these relative conditions, heat will be conveyed from south to north. These are permanent conditions, and so account for the same end of the magnet always pointing towards the same pole of the earth. There is not only this difference between the two hemispheres; the more northern parts of the northern hemisphere are more especially land regions, the proportion of land greatly increasing towards the north. The more condensation converges northward, and the more evaporation converges southward, the greater will be the intensity of the horizontal force; and the more the hygrometric transformations are diffused over the earth the less will be the intensity. Evaporation is probably much more influential (directly) in producing magnetism than condensation is, because it occurs on the earth, whilst condensation occurs in the atmosphere. The amount of evaporation (and of condensation also) in any given spot, or in any given latitude, will vary considerably, according to the nature of the regions the sun, at the time, is passing over, or passing from, or approaching to; and thus several periods of great intensity and several of small intensity may occur in the course of the year. And the same declination of the sun does, in fact, give similar values for horizontal force when the declination is decreasing as when it is increasing. This symmetry in the values is shown in the following Table, the magnetic phenomenon occurring generally a few days subsequent to the declination it is connected with in each case.

		d h		° ′
See Maxima, Table IV.	November 12, 1842 January 29, 1843	each 0 15	before declination	17 51 S.
	October 8, 1842 March 9, 1843	each 1 18	after "	5 18 S.
	March 27, 1842 September 16, 1842	each 0 5	before "	2 38 N.
	April 28, 1842 August 23, 1842	each 3 23	after "	12 50 N.
	May 26, 1842 July 29, 1842	each 5 2	after "	20 9 N.
See Minima, Table IV.	October 28, 1842 February 18, 1843	each 1 23	after "	12 26 S.
	September 22, 1842 March 16, 1843	each 2 21	before "	0 44 S.
	April 13, 1842 September 5, 1842	each 2 21	after "	7 57 N.
	May 13, 1842 August 13, 1842	each 6 12	after "	16 38 N.
	June 9, 1842 July 5, 1842	each 0 14	after "	22 53 N.

With one exception, the second in order of each pair of dates in this Table is associated with the higher value for horizontal force when the declination is south, and the first is associated with the higher value when the declination is north. Hence it appears that the same declination is accompanied by the more active evaporation when the temperature is rising in the northern hemisphere, and that the same declination is accompanied by the less active evaporation when the temperature is falling in the northern hemisphere.

There are four exceptions to this rule of symmetry. June 21 gives a maximum value; and of course this day cannot have any fellow in declination. December 10, November 29, and November 22 are also exceptions. These are the three dates which stand the nearest of those in the Table to the extreme south declination of the sun; and the hygrometric conditions do not alternate and recur as the sun approaches and recedes from the southern tropic; they remain pretty much the same between November 22 and January 20 in the southern hemisphere, and in the northern hemisphere they are progressive during this period instead of recurrent. The result is, that the changes in intensity are not symmetrical on the two sides of the solstice.

The intensity is never very great whilst the sun is near the southern tropic. The explanation of this may be, that evaporation is not great, even in the southern hemisphere, when the sun has great south declination, evaporation being checked in this hemisphere by accumulation of vapour. When the sun's influence has been brought more to bear on more northern regions, the increased vapour there is quickly removed through the condensation effected by the land districts (by the districts of great elevation, probably); and this would lead to evaporation being maintained in the lower latitudes with an activity proportionate to the temperature there. The minimum intensity occurs on December 10; and this may be taken to be the date of minimum hygrometric action, or of minimum hygrometric contrast: December 3 gives the highest value for humidity at Newport; and evaporation will have abated at this period of the year in the southern hemisphere, owing to the highly vaporized state of the atmosphere there. Humidity is great in one hemisphere through decrement of temperature, in the other through increment of vapour. In the northern hemisphere the season of active deposition has passed by, and that of active congelation has not arrived: this may be said to be the epoch of passivity, or date of minimum activity, as regards hygrometric transformations. A considerable rise in the values for horizontal force is observable at the beginning of January, the intensity increasing from December 10 to January 29 almost constantly; and then an inconsiderable fall ensues: the greatest increase in the daily values at this period of the year occurs on January 4. Hygrometric conditions are of course in a great degree dependent on temperature, and the thermometer may often be referred to as an indicator of the hygrometric state*. Minimum temperature occurs at Greenwich on January 9. At Newport the minimum for the year occurs on February 11, but on January 5 a minimum occurs which is only 0°·5 above that of February 11. At a station in the Arctic region a minimum temperature of —32°·4 occurs on January 5, and the minimum for the year, viz. —37°·8, occurs on February 13†. Rapid extension of frost appears, therefore, to abate at the same time that the increment in the horizontal force abates, *i. e.* January 5. Increment of temperature continues at Newport to January 25, and at the Arctic station to January 27, and at Greenwich diminished increment coincides with the decrement noted for the other two stations. The values for horizontal force commence a slight decline on January 31; it would appear, therefore, that the transformation from liquid to solid ceases to be the rule in the northern hemisphere at this date, though we have no certain knowlege of the fact. Minimum temperature, in fact, occurs on February 11 at Newport, on February 13 at the Arctic station, and at Greenwich a minimum occurs on February 13; but this last is as much as 2°·3 above the minimum for the year, which occurs full a month earlier. There is, therefore, at least a strong probability that the change from increment to decrement in the horizontal force at the end of January may be cotemporaneous with the cessation of freezing in the northern parts of the earth, or with commencement of deposition (*active* deposition) in high southern latitudes.

The values for horizontal force rise above the mean on January 5, and continue above the mean to June 6. This is consistent with the hypothesis that the high values are maintained during the greater part and the latter part of this period of the year by active evaporation in tropical latitudes. That is to say, this long period of high values is the result of northern frost at first, and of evaporation in more southern latitudes subsequently. On June 7, when the intensity falls below the mean value, the sun is close upon the northern tropic, and he may be said to have reached the northern limit of the Indian Ocean. His position is, therefore, a critical one as regards hygrometric action; a very wide area of land is now placed immediately to the north of his position, instead of a great extent of sea. It is only in a small degree, and for a short time, however, that the values are below the mean. The sun at this period of the year is nearly stationary; heat and evaporation must consequently become very great under his vertical rays, and the intensity attains a high value on the 21st (considerably higher than on the 6th). They fall again considerably in the early part of July, and then rise to the maximum on July 29; and at this date the sun's rays fall again and with accumulated force on the Indian Ocean; it may be supposed that evaporation is at its maximum at this time. The intensity falls to a value below the mean on August 7, and it does not rise above the mean again till January 5. The northern atmosphere must be highly vaporized at the date August 7; and this, by checking evaporation, may suffice to bring the horizontal force down to its mean intensity. Maximum temperature occurs both at Greenwich and at Newport on August 3, and at the Arctic station on July 22; and vapour-pressure is at its maximum at Newport on August 1 (or at least the dew-point temperature is at its maximum on this day).

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* All the thermometric values quoted in this paper are taken from Tables which have been computed by the method that was adopted for the construction of the Tables here particularly concerned. The Table used for Greenwich is to be found in No. 21 of the 'Proceedings;' there can be no doubt, I think, that this is the right Table to quote from for the present purpose, it having been computed similarly with the other Tables of daily value referred to. The Table for Newport is to be found in 'Meteorology of Newport' (a copy of which is in the Society's Library); and the other Table referred to is included in the Appendix to the same volume: this Table was computed from Sir John Ross's Tables for lat. 70° N., long. 91½° W.

† The annual range at Newport is 23°, at the Arctic station it is 82°.

It has been mentioned that humidity is at its maximum value on December 3 at Newport, whilst the horizontal force is at its minimum on December 10. Humidity is at the lowest on April 21; and the value for horizontal force on April 28 is 146 (147 being the maximum), and on April 21 it is 143. The temperature at Newport for the 3rd of December is 42°·1 (at Greenwich 41°·8), and the value for dew-point at Newport is 38°·6. On March 19 temperature is the same as on December 3 at Newport (at Greenwich it is the same on March 17 as on December 3); and the dew-point on the former date is 6°·9 below temperature, instead of 3°·5 as on December 3; the value for horizontal force on March 19 is 143.

TABLE I.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	133·11	142·09	142·60	144·38	145·29	139·70	130·84	145·62	129·64	130·79	128·30	130·10
2	133·86	141·90	142·86	143·91	144·74	138·98	129·75	144·16	129·22	130·90	128·50	129·96
3	134·72	141·70	143·05	143·35	144·08	138·23	128·99	142·23	128·94	131·06	128·88	129·72
4	135·63	141·41	143·14	142·71	143·35	137·51	128·52	140·18	128·80	131·17	129·28	129·40
5	136·49	141·06	143·23	141·99	142·49	136·88	128·38	138·26	128·78	131·25	129·65	128·96
6	137·33	140·72	143·40	141·43	141·58	136·32	128·68	136·57	128·87	131·34	129·93	128·49
7	138·15	140·46	143·41	141·01	140·74	135·89	128·80	135·16	129·05	131·40	130·11	128·09
8	138·89	140·25	143·46	140·60	140·00	135·62	129·03	134·01	129·27	131·40	130·22	127·77
9	139·48	140·04	143·47	140·20	139·44	135·52	129·36	133·15	129·56	131·37	130·22	127·53
10	139·95	139·85	143·40	139·81	138·99	135·53	129·84	132·49	129·89	131·27	130·16	127·29
11	140·23	139·67	143·25	139·46	138·72	135·61	130·41	132·05	130·20	131·12	130·20	127·51
12	140·55	139·54	143·09	139·18	138·55	135·80	131·02	131·80	130·45	130·88	130·22	127·64
13	140·80	139·42	142·85	139·07	138·50	136·08	131·50	131·79	130·63	130·52	129·96	127·88
14	141·02	139·41	142·77	139·11	138·62	136·43	131·84	131·83	130·74	130·16	129·69	128·21
15	141·17	139·32	142·66	139·31	138·63	136·81	131·99	131·91	130·76	129·85	129·42	128·68
16	141·24	139·25	142·53	139·69	138·80	137·23	132·27	131·99	130·77	129·57	129·19	129·22
17	141·23	139·17	142·63	140·16	139·14	137·61	132·71	132·03	130·75	129·32	129·07	129·74
18	141·18	139·15	142·76	140·71	139·56	137·90	133·35	132·05	130·73	129·13	129·01	130·22
19	141·17	139·26	142·94	141·31	139·98	138·09	134·18	132·06	130·69	128·93	129·00	130·62
20	141·21	139·45	143·22	141·96	140·44	138·24	135·20	132·16	130·65	128·73	129·00	130·90
21	141·26	139·73	143·60	142·67	140·86	138·36	136·39	132·31	130·60	128·56	128·88	131·13
22	141·35	140·04	144·01	143·41	141·24	138·36	137·80	132·42	130·57	128·40	128·85	131·27
23	141·43	140·36	144·50	144·12	141·58	138·11	139·43	132·47	130·57	128·31	129·04	131·31
24	141·53	140·58	144·89	144·76	141·87	137·65	141·33	132·43	130·63	128·17	129·27	131·26
25	141·69	141·01	145·30	145·38	142·09	137·00	143·33	132·30	130·72	127·99	129·59	131·15
26	141·89	141·44	145·68	145·82	142·21	135·91	145·00	132·09	130·76	127·79	129·90	131·07
27	142·09	141·88	145·73	146·05	142·12	135·03	146·27	131·82	130·76	127·69	130·10	131·05
28	142·23	142·28	145·59	146·11	141·88	134·08	147·08	131·50	130·73	127·66	130·21	131·13
29	142·29	......	145·37	145·99	141·50	133·08	147·42	131·16	130·71	127·70	130·24	131·39
30	142·28	......	145·10	145·72	140·97	131·98	147·27	130·68	130·73	127·85	130·15	131·82
31	142·23	......	144·77	......	140·37	......	146·68	130·12	......	128·08	......	132·36

TABLE II.

Maximum	66°·5	February 26.
Minimum	56·3	August 14.
Means	61·2	May 27.
	61·2	December 9.

TABLE III.

	Sums.	Means.	
January	4337·68	139·92	=140
February	3930·44	140·37	140
March	4455·26	143·72	144
April	4269·38	142·31	142
May	4368·33	140·91	141
June	4099·54	136·65	137
July	4194·66	135·31	135
August	4150·80	133·90	134
September	3905·17	130·17	130
October	4018·36	129·62	130
November	3886·24	129·54	130
December	4022·87	129·77	130
Mean	....	136·02	

TABLE IV.

Maxima.		Minima.	
29 January	142	139	February 18.
9 March	143	143	March 16.
27 March	146	139	April 13.
28 April.....................	146	138	May 13.
26 May	142	136	June 9.
21 June	138	128	July 5.
29 July : maximum	147	132	August 13.
23 August	132	129	September 5.
16 September	131	131	September 22.
8 October..................	131	128	October 28.
12 November...............	130	129	November 22.
29 November...............	130	127	December 10 : minimum.

TABLE V.

January 4.
June 6 to 14.
June 26.
July 21.
August 6.

The whole range in the values for horizontal force between September 16 and December 10 is only 3·5, whilst between July 5 and July 29 the range is 19·0. Between February 18 and March 9 it is only 4·3. Between December 10 and January 29 it is 15·0. The horizontal force increases in intensity daily from July 5 to July 29, the increase amounting to 19 in fourteen days; this must be a period of very active evaporation in the northern intertropical latitudes. The intensity increases 15 in fifty days between December 10 and January 29; this increment may be attributed to the influence of frost in the higher northern latitudes.

CXXXI. *On the Evaporation of Rain from Rain-gauges.*

By G. HARVEY SIMMONDS, Esq., F.M.S.

AT the beginning of the present year there were several discussions, at meetings of the Meteorological Society, on rainfall and on rain-gauges, at which it was stated that much of the rain collected by the gauge was lost through evaporation before it was measured by the observer. To see whether the loss was as large as had been represented, I made a few experiments, of which the following is a short account.

The receiving-can* and measuring-glass of an 8-inch Glaisher's gauge, each containing a known quantity of water, were placed in the gauge freely exposed to the sunshine and wind in a large garden and allowed to remain for a month, at the end of which time the water was remeasured, and the loss was found to be equivalent to a decrease in the rainfall of:—

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* The diameter of the receiving-can was 4·75 in. and of the measuring-glass 2·1 in.

1866. Month.	From measuring-glass.	From receiving-can.	Weight of vapour required to saturate a cubic foot of air.	Daily horizontal movement of the air.
	in.	in.	grs.	miles.
In April............	0·016	0·080	0·8	292
„ May	0·021	0·118	1·2	240
„ June	0·020	0·120	1·4	242
„ July	0·019	0·122	1·4	233

The last two columns of the above Table contain the mean weight of vapour required to saturate a cubic foot of air, and the mean daily horizontal motion of the air at Greenwich, as given by Mr. Glaisher in his 'Quarterly Reports,' for the months during which the experiments were carried on. It is on these two meteorological elements that the evaporation must chiefly depend; and the changes in the losses from evaporation will be found to correspond closely with their joint variations. For in May the quantity of water evaporated was nearly 50 per cent. more than in April, and in the former month the weight of vapour required to saturate a cubic foot of air was 50 per cent. more than in the latter; but, the mean horizontal motion being less, the evaporation would be not quite 50 per cent. more in May than in April, as it was found to be. Again, in May, June, and July, in which months the quantities of water evaporated were nearly equal, the weight of vapour required to saturate a cubic foot of air and the mean daily horizontal motion of the air were nearly constant. The values of the above elements for Greenwich have been used in the comparisons, as the best that could be obtained, and from having been deduced from observations made at a less distance from the place where the experiments were carried on than any other published.

For the three months during which the evaporation was most rapid, the rainfall measured would have been on an average too little by 0·004 in. for every day that elapsed between the time of fall and the time of measurement, supposing the evaporation to have gone on uniformly: but daily inspection of the measuring-glass showed that during periods of damp or rainy weather the evaporation was almost nil, as might have been expected from the usually near approach of the air to the point of saturation at these times. The error due to evaporation in the rainfall measured will, therefore, be very small, if the gauge be properly constructed and read daily; but if, on the contrary, it is only read monthly the error will probably amount to about two-tenths of an inch in the summer; and if, as is often the case with gauges intended to be read only once a month, there is no receiving-can, but the rain is allowed to run into the cylinder, the error may exceed half an inch. As the error is accumulative, very little reliance can be placed at present on the yearly rainfall obtained from gauges read only monthly, as it must greatly depend on the relative humidity of the different years. As the evaporation varies with the surface exposed, as well as with the dryness and movement of the air, the numerical values of the errors given above are only true for gauges of 8 inches in diameter, with receiving-cans of 4¾ inches in diameter, and when the atmospheric conditions are similar to those of April, May, June, and July 1866.

On p. 224, vol. iii. of the 'Proceedings' of the Society, Mr. Symons alludes to a case in which the loss by evaporation was fifteen-hundredths of an inch; this would certainly be a very large quantity to lose in a single day in our part of the world; but the sentence is so loosely worded that it is impossible to make out out whether the loss occurred in a single day or in a month, or whether the case is not a supposititious one altogether, which I am inclined to believe it to be, more especially as he makes the evaporation depend directly on the rainfall, which appears to me very improbable.

In conclusion, it may be as well to mention that the gauge was a copper one, neither painted nor varnished, and that proper precautions were taken to prevent the rain collected by the funnel from entering either the receiving-can or the measuring-glass, and to keep the small pipe at the bottom of the funnel clear, so that there should always be a free communication between the air inside and outside of the gauge.

CXXXII. *On the Difference of Temperature of Two Strata of Air at unequal heights.* A communication by Professor D. Ragona-Scina, Director of the Royal Observatory at Modena, to the Austrian Meteorological Society. Translated, with *Addenda*, by J. Staughton Harding, Esq., F.M.S.

N.B. All measures are converted into English equivalents.

In a report on the valuable meteorological observations made at Oxford in the year 1863 by Professor Main (of the Radcliffe Observatory), mention is made, among other results, of those obtained by the placing of two thermometers, one 5 feet, the other 105 feet above the ground. *The upper thermometer showed continually a higher temperature than the lower*, with a single exception in May and June. This remarkable peculiarity of temperature near to the earth was reported to have been discovered by Dr. Trestel, at Emden.

In relation to these observations, I may perhaps be allowed to give an account of some similar and hitherto unpublished experiments commenced by me in the month of October 1865.

These observations were taken at 4^h P.M. and at midnight; the following is the result of the first series, extending from October 1865 to April 1866 inclusive. Having obtained two excellent thermometers, made by Salleron, and compared with each other, and having had a window constructed exactly 23 feet in perpendicular height above that of my Observatory, and of the same dimensions as the latter, I placed the two thermometers in a vertical line, and, with the exception of height, under precisely identical conditions,—for the purpose of making experiments on the relative difference of temperature of two horizontal strata of air at different yearly and daily periods. The lower thermometer was fixed at 98 feet, and the upper at 121 feet, above the ground.

The observations taken at 4^h P.M. *gave almost continually a lower reading of the upper thermometer*. The few exceptions, in which the indications of the upper thermometer were higher than those of the lower thermometer, always occurred in exceptional weather, *i. e.* with rain, with cloudy or overcast sky, with heavy wind, but especially with fog in the lowest regions. *At* 4^h P.M., *therefore, a stratum of air* 98 *feet above the ground is, generally*, i. e. *under normal conditions, warmer than a stratum of air* 121 *feet high.* Conditions which occasion a change in this distribution of temperature are, as already mentioned, rain, heavy wind, fog, &c. As soon as any of these last meteorological elements prevail, the lower stratum of air becomes colder than the upper.

December 1865 affords a beautiful illustration in point. On the 8th, 11th, 12th, and 13th of that month, the lower stratum of the atmosphere at Modena was unusually misty; and on those days I found the upper stratum of air nearly a degree warmer than the lower. On the 18th, 19th, 20th, and 21st of December, on the contrary, the sky was clear, the air calm, and those days are entered in my meteorological journal as among the finest of the year; on those days I found the upper stratum of air nearly

1°·8 colder than the lower. The means of the differences of temperature as observed by me at 4^h P.M. are as follows:—

Excess of Temperature shown by the Lower Thermometer.

October 1865	+0°·482
November „	+0·553
December „	+0·758
January 1866	+0·724
February „	+0·599
March „	+0·367
April „	+0·144

At midnight I found the upper stratum of air warmer than the lower, almost continually. The few exceptional cases always coincided with those meteorological conditions which at about 5^h P.M. cause, by exception, an excess of heat in the higher strata of the atmosphere, especially with heavy wind, or with fog.

At midnight, therefore, a stratum of air 98 *feet above the surface of the ground is, generally,* i. e. *under normal conditions, colder than a stratum at a height of* 121 *feet above the ground.* The differences found at midnight, expressed in mean values, are as follows:—

Defect of Temperature shown by the Lower Thermometer.

October 1865	−0°·913
November „	−0·376
December „	−0·616
January 1866	−0·547
February „	−0·385
March „	−0·394
April „	−0·799

From a long series of observations, the law according to which the differences in the various yearly periods, and at different hours, undergo a change, and to what perpendicular height they are found to exist, may be deduced with precision. It undoubtedly results from these observations that "the decrease of temperature with the increase of height" does not hold good as a general rule, since, at a height of 98 feet above the ground and of 207 feet above the sea, the slight difference of 23 feet in vertical height is sufficient to show that at night, under ordinary normal conditions the upper stratum of air is always warmer than the lower,—and that under extraordinary anomalous conditions the same takes place by day, especially on rainy and stormy days, or when fog prevails in the lower strata—in which cases a mingling of unequally heated strata of atmosphere occurs.

From this result many deductions may be made; sufficient only is mentioned here to show, among other things, what a small degree of exactness in investigating the temperature of local air (*i. e.* of those strata of air surrounding the meteorological instruments which are to determine the atmospheric conditions at any given moment) is attainable by registering-thermometers the readings of which are determined by a metal wire extending, not horizontally, but vertically, to a length of 60–64 feet.

There also results from these observations new evidence of the unreliability of the reduction to the level of the sea of isolated barometrical observations, as the temperature of air at one station cannot be deduced, according to any general formula, from that of another station perpendicularly above it.

I intend, shortly, to publish a second series on this subject.

Addenda, embodying Remarks of MM. FRITSCH and TRESTEL *on the subject.*

N.B. All measures are converted into English equivalents.

In a communication to the Meteorological Society of Vienna, Dr. Trestel says:—"I am glad that attention is again drawn to the increase of temperature with height. It is not only a matter of fact, but, what by many persons will be considered of more import, it may be proved *à priori* to be absolutely necessary, as may easily be found if we examine the subject more closely. I have continued my observations down to the present time, and always find the same yearly period; while the daily deviations are very different, according to wind and weather. I made my observations with two minimum-thermometers, one being fixed about 6 feet above the ground on the north side of my house, the other, at the east side of my Observatory, placed 42 feet above the ground, both in a free and open space. By these observations the increase of temperature is shown in the most conclusive manner. The monthly means of the lowest readings of the instruments are as follows:—

1866.	At 6 ft.	At 42 ft.	Difference.
January	34·25	34·47	+0·22
February	33·33	33·53	+0·20
March	30·22	30·63	+0·41
April	39·33	39·63	+0·30
May	40·39	40·84	+0·45
June	54·63	55·13	+0·50
July	52·45	53·01	+0·56
August	52·32	52·95	+0·63

The following fact is explained by the increase of temperature:—when in winter, after snow has fallen, a thaw sets in, but the temperature is not far from the freezing-point, the snow entirely disappears from the north sides of the roofs (the south sides naturally cannot be taken into consideration), while it is still to be seen several days afterwards on the ground."

With reference to the earlier results obtained (some years since) at Emden, M. Carl Fritsch observes that Dr. Trestel himself appears to have doubted the universal validity of the stated anomaly in the variation of the temperature, inasmuch as he expressed a wish that similar observations might be undertaken at other places. The increase of the mean temperature, as found by him at a height of only a few yards above the ground, was so considerable that the better determination of the matter seemed of the highest importance; whilst the value of completed series of observations, of which the height above ground of the thermometers used was not known, was called into question.

Dr. Trestel's appeal was apparently first taken up in Vienna, by the late Dr. Kreil, who placed five thermometers at different heights at the Imperial Central Meteorological Institute. The observations then commenced were continued and completed by M. Carl Fritsch (Dr. Kreil's successor *ad interim*), the whole making a series of two years' observations taken at several fixed hours daily, the results of which have been published (Proceedings of the Imp. Acad. of Sciences, vol. lii. 1865). These investigations showed an increase of temperature with height, as at Emden, but to a much smaller degree, and the heights at which the extremes of the mean temperatures occurred did not correspond; so that the question may fairly be regarded as still undecided.

The recently published results obtained by Dr. Trestel appear (says M. Fritsch) even less conclusive than his earlier experiments. Had Dr. Trestel also made observations with maximum-thermometers, and had these given results similar to the minimum-thermometers', one might have felt more satisfied, although the fact still remains that according to the more recent observations the changes of temperature with height are considerably less than according to his earlier observations. Again, the indications of minimum-thermometers are not so reliable as to prevent one from being tempted to attribute the differences to a change of the instruments.

In reply to Dr. Trestel's remark respecting the effect of the *increase* of temperature with height, as shown by the snow, M. Carl Fritsch mentions the following circumstance, which he ascribes to the effect of the *decrease* of temperature with height:—"When, in autumn, the first snow falls, and the temperature is not far from the freezing-point, the snow accumulates on the north sides of the roofs several days before it begins to lie upon the ground. The same occurs in winter when snow falls after a warm period."

In winter (continues M. Fritsch) the excess of heat at some height above the ground, as compared with that on the surface of the earth, should stand out in a striking manner when we consider that, on clear days, when the ground is covered with snow a temperature is always observed on the surface of the snow, at least with calm air, which may be from about 11° to 22° below that which is met with at a small height above the surface of the snow. This excess of heat in the higher stratum of air as compared with that resting upon the ground is not greatest in the winter, but in the summer months.

In the beginning of October 1857 I ascended, on a clear moonlight night, the peak of the Hermann, near Vienna, 1763 feet high, and I was not a little astonished to find along the whole ridge to which the peak belongs a considerably higher temperature at midnight than I had observed some hours earlier at the foot of the mountain. Here, however, the air was calm, whilst on the mountain a brisk south wind was blowing. On calm clear nights we regularly find, in valleys, a much lower temperature than on the neighbouring hills. In the daytime, when the sun is shining, the conditions are reversed, and a compensation occurs, which must also take place during the course of the year. There appear, then, some facts for and others against the decrease of temperature with height in the lowest strata of the air, the majority being perhaps for the increase.

CXXXIII. *On the Anemometers at the Royal Observatory, Greenwich.* By JOHN BROWNING, F.R.A.S.

[PLATE VII.]

FOR some months I have been occupied at the Royal Observatory, under the direction of the Astronomer Royal and Mr. Glaisher, in perfecting the apparatus for registering the force of the wind, and at the same time in erecting a new instrument, from plans by the Astronomer Royal, for registering the velocity. Of the mechanical construction and operation of these instruments I now propose to furnish a detailed description, accompanied by drawings of their several parts.

I will first describe the instrument for registering the velocity of the wind, as shown in Plate VII. figs. 1 & 2. The portion of this apparatus which is outside the building, is represented in fig. 1. A, A, A, A, are four hollow hemispherical cups of copper, attached by a light framework to a central spindle, B, which is carried round by the revolution of the cups. At the lower end of the spindle is an endless screw, which cannot be shown in the drawing, but which, revolving by the action of the cups, communicates motion to a train of wheelwork, so arranged that each wheel moves more slowly than the wheel preceding it, from which it receives its own motion. A pinion, C, attached to the wheelwork, works into a rack, J, and raises a rod, D, which is carried down into the interior of the building. A continuation of this rod is shown in fig. 2, where it is indicated by the same letter, D; to it is fastened a slide, E, carrying a pencil, F (fig. 2). In front of the pencil there is a metal cylinder, I I (fig. 2), to which is given by clockwork a rotatory motion. The gearing by which this is effected is shown at G (fig. 2).

A sheet of paper is wrapped round the cylinder, and held in position by springs; upon it there are vertical lines to indicate hours, and horizontal lines for velocity. It will thus be seen that, when the cylinder is revolving at a known speed, the pencil, F (fig. 2), being raised by the rod, D (fig. 2), will draw a line that will vary more and more from the horizontal as the cups travel with greater rapidity; for the rack, J (fig. 1), being raised by the pinion, C (fig. 1), will elevate the rod, D, a greater amount in a given time if the cups be moving at a higher speed.

At the commencement of each day's registration, the rack is brought to the zero of the paper, in the following way:—The spring, L (fig. 1), is pressed back, and the rack, J, turning on a hingejoint at M (fig. 1), lowers the rod, D, to the zero-line on the new paper. The front of the instrument (which, in the drawing, fig. 1, is supposed to be turned from the observer) has four small dial-plates, upon which, by means of indices, the velocity of the wind is registered in tenths of miles, miles, tens of miles, and hundreds of miles. The sensitively delicate character of this instrument is such that the cups will revolve with a breeze so light as scarcely to be perceptible to the sense; whilst, during gales, it has recorded velocities of from thirty to forty miles per hour.

I now proceed to describe the instrument for registering the corresponding pressure of the wind, this being a matter of great interest to scientific and nautical men. The acting portion of this apparatus consists of a circular disk of iron equal to 2 square feet in area (see fig. 3). It is very light, but is strengthened by stays of thin sheet steel placed edgeways behind it. It is supported by eight tempered steel springs, shown at D, D, D, D. When the wind blows against the circular plate, the springs are brought successively into action, the stronger being so arranged as to take up the pressure before the weaker are subjected to any strain. The plate is kept facing the wind by the action of a direction-vane, B, with which it is connected. A rod, G, which moves with the pressure-plate, carries a fine flexible wire cord, H, which, though not readily seen in the drawing, passes over a small pulley in the side of the rod carrying the direction-vane, and runs down through the rod, which is made hollow for the purpose. This wire is continued into the building, where it governs the motion of a pencil, which traces on a sheet of paper the pressures which the circular plate has received. The paper is stretched upon a horizontal travelling board covered with slate, which is moved uniformly by clockwork. Upon it there are vertical lines indicating hours, and horizontal lines for pressures.

This instrument is so sensitive that it will record pressures as light as a fraction of an ounce on the square foot, whilst in gales it will support a force as great as 40 lb. on the same area.

I am greatly indebted to Mr. Glaisher for the constant and untiring attentions which he has given me during the whole of the time I have been occupied in perfecting these instruments.

CXXXIV. *Notices of Luminous Meteors seen in the Month of August, extracted from the Meteorological Register kept on board the Barque 'James Longton.'* By Captain H. S. MILLARD.

AUGUST 7, 1866. From 8^h to 12^h P.M. a large number of meteors seen, some shooting from N.E. to S.W., others from N. to S.E.; one was especially brilliant and large, and of an intensely blue colour, leaving a vivid train of light after it, having traversed from the N.E. southerly.—In about lat. 31° 40′ N., long. 136° 35′ E.

August 10, 1866, 8^h P.M., large and brilliant meteor traversing from N.W. to S.E.—Lat. 30° 43′ N., long. 134° 23′ E.

August 11, 1866, from midnight until 3^h A.M. a large number of meteors seen, some shooting in various directions, and others blazing out and then dying away without shooting; a few traversed a considerable distance, but the majority a very short distance. All of them seen in the north.—Lat. 30° 38′ N., long. 134° 25′ E., at midnight.

August 12, 1866, between 1^h and 3^h A.M., large numbers of meteors seen, starting from about W.S.W., most of them with a bright train of light. They were so numerous and followed each other so quickly that I could not take special notice of any one. —Lat. 28° 50′ N., long. 134° 20′ E., at about 2^h A.M.

August 13, 1866, at 12^h 15^m A.M., a magnificent meteor appeared, traversing from 35° to 40°, starting from the W.S.W. After traversing about 20° it burst into three parts and disappeared. It was of a bright blue colour; the whole sky was quite darkened by contrast, so brilliant was its light, though it was a fine clear starlight night; and we could not see distinctly for several seconds afterwards, so intense was its glare. There were numerous others, mostly from the N.W. quarter, frequently five and six at once.—Lat. 28° 14′ N., long. 133° 58′ E., at midnight.

August 14, midnight, several small meteors; 2^h A.M. numerous meteors.—Lat. 28° 7′ N., long. 133° 36′ E., at midnight.

August 17, at 10^h P.M., several meteors shooting to the N.W. —Lat. 28° 14′ N., long. 129° 50′ E.

August 20, at 2^h A.M., a large meteor with a long bright train of light shot to the N.N.E. from the zenith.—Lat. 31° 34′ N., long. 129° 0′ E.

FIG 3.

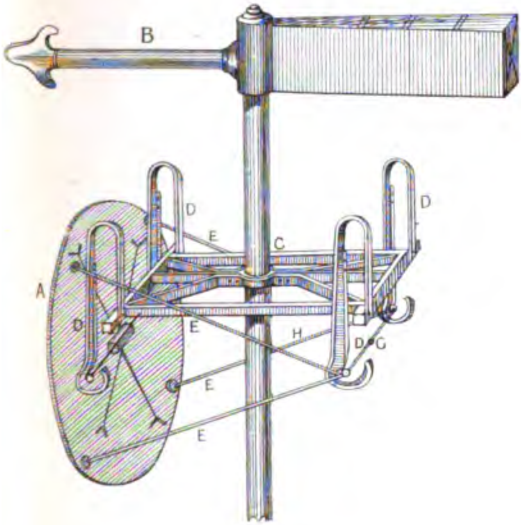


FIG. 1.

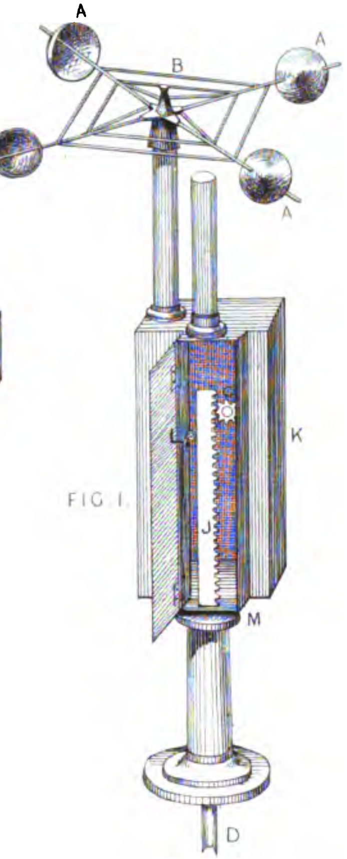
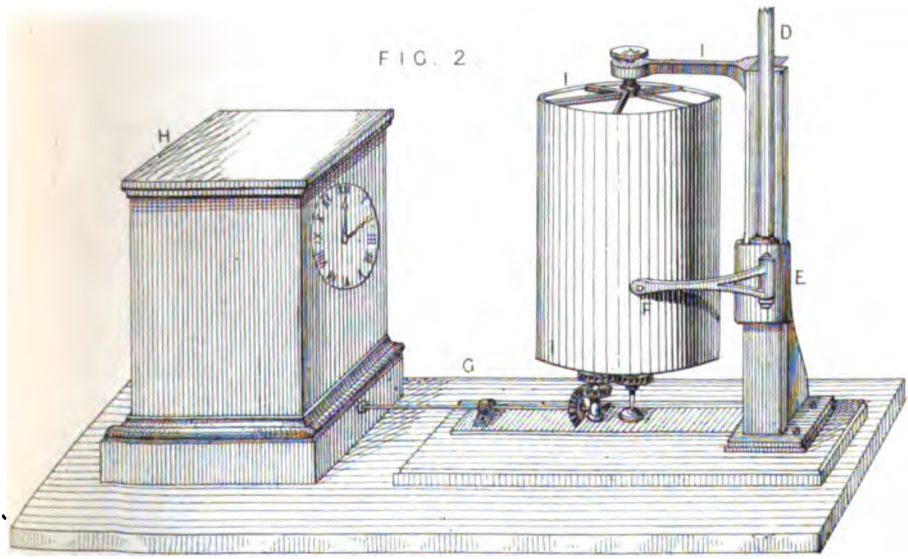


FIG. 2.



J. Basire, lith.

[*Price Two Shillings.*]

Vol. III.] [No. 29.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, Esq., F.R.S., Secretary.

1867, FEBRUARY 20.

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VOL. III. 1867, FEBRUARY 20. [No. 29.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Alfred Carpenter, Esq., M.D., Croydon;
Rev. W. Tuckwell, The College School, Taunton;
Thomas A. Compton, Esq., M.D., L.R.C.S., M.R.C.S., 2 Palmenton Gardens, Bournemouth;
Frederick M. Williams, Esq., M.P., Goovrea, near Truro;

were balloted for and duly elected Fellows of the Society.

The names of Four Candidates for admission into the Society were read.

CXXXV. *The Evaporation-Gauge (Atmometer) in its Simplest Form.* By Dr. M. A. F. PRESTEL. Translated from the 'Zeitschrift der österreichischen Gesellschaft für Meteorologie,' vol. i. No. 13, by G. HARVEY SIMMONDS, Esq., F.M.S.

IN the memoir* on the rainfall of the Kingdom of Hanover, and in the 11th No. of the 'Proceedings' of the Philosophical Society of

---

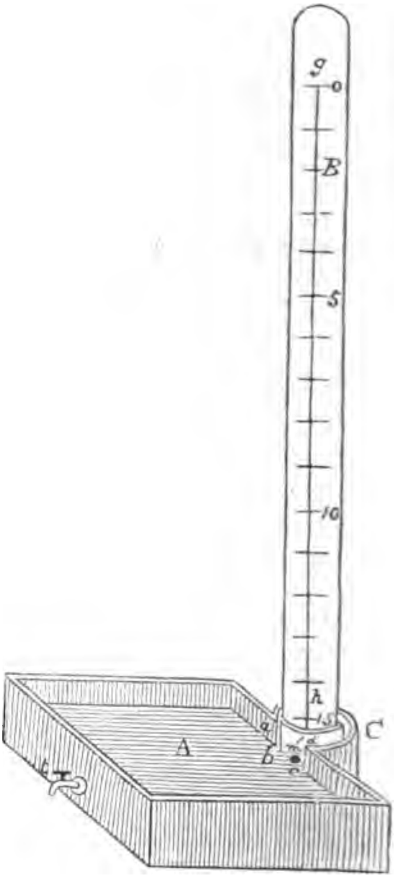
* Die Regenverhältnisse des Königreichs Hannover, nebst ausführlicher Darstellung aller den atmosphärischen Niederschlag und die Verdünstung betreffenden Grössen. Emden, 1864.

Emden is a full description of a simple evaporation-gauge invented by me [Dr. Prestel]. The peculiarity of the construction of the instrument is shown in the accompanying figure 1. A is an open square vessel to contain the water to be evaporated, B C a measuring-tube with an opening *m*, through which there is a communication between the interior of the tube and the water in A. The water which evaporates from A will be continually replaced from that in the tube through the opening *m*. Thus the water in A will be always kept at the same height, the quantity evaporated after the tube has been filled and fixed in its place being read off from the scale *g h* on the measuring-tube.

The opening *a*, *b*, *c*, *d* being closed with a slide, made of fine wire-gauze fixed in a frame, and the vessel A filled with sand, mould, turf, or with earth thickly covered with vegetation, the quantity of water evaporated from these substances can be read off from the scale of the measuring-tube as easily as before, and the coefficient of evaporation determined.

I have had the instruments made of various sizes and furnished with various measures. For observations of the same kind, all have given results which agree very well. Hitherto, owing to the closing conical valve, the interior of the measuring-tube could not be reached before filling and fixing the tube in its position; but this is essentially necessary, in order to clean the inner surface of the tube from the oxidized matter which in summer time accumulates in the course of twenty-four or forty-eight hours. The formation of the green

Fig. 1.



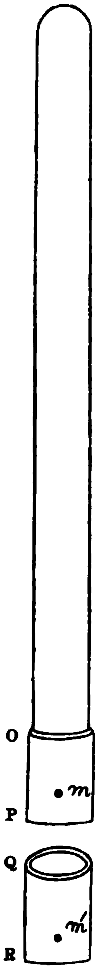
matter may be easily prevented by adding a few drops of nitrate of silver to the water; but not so that of the fine deposit which in time fixes itself on the inner surface of the tube.

I have therefore now given to the measuring-tube the following simple and successful mounting, which is more easily constructed than the valve, shuts closer after the tube is filled, and, what is of more importance, the interior of the tube can be reached through it, and its surface cleaned and polished each time before it is refilled.

This mounting consists of a ring of thin brass O P, fig. 2, into which the open end of the tube is forced about half the breadth of the ring, and there firmly soldered. In the lower half of the ring a semicircular opening *m* is filed, having a radius of about one Paris line (0·09 English inch). On to this ring a cap of brass Q R fits tightly. In the side of the cap there is also an opening *m'*, which may be brought exactly over the opening *m* by turning the cap, which will allow the water in the measuring-tube to flow out into the vessel A, if the tube is in the cylinder C attached to vessel A. To fill the tube, hold the open end upwards, closing the hole *m* at the same time with the finger, pour in the water, and then force on the cap Q R, but so that *m* and *m'* shall not come together. Invert the tube and place it thus closed and filled in the cylinder C, fig. 1; then turn it round so that *m* shall coincide with *m'*, and then there will be a free communication between the water in the measuring-tube and that in the evaporating-vessel.

Now turn the tap *t*, and let enough water flow off to bring the top of the column of water in the measuring-tube down to the zero of the scale. The shortening of the column of water in the measuring-tube, for any time afterwards, can be read off from the attached scale, and will give, if subtracted from the previous reading, the amount of water evaporated since that reading.

Fig. 2.



CXXXVI. *Atmospheric Pressure in Natal, South Africa.* By R. J. Mann, Esq., M.D., F.R.A.S, F.R.G.S., F.M.S., &c., Superintendent of Education in the Colony.

[Plate VIII.]

At the concluding meeting of the Meteorological Society last year, I had the pleasure, having then but just landed in England, to present to the Society a brief sketch of "The Leading Features of the Climate of the Colony of Natal, South Africa," derived from a continuous series of eight years of meteorological observations taken by standard instruments at my observatory at Maritzburg the capital city of the colony. It will be remembered that I prefaced the sketch by a description of the physical conformation and geographical position of the colony. This description will be found at page 203 of the 'Proceedings' of the Society for the year 1866; and this portion of the subject will be more fully developed in a paper in vol. xxxvii. of the 'Journal' of the Royal Geographical Society.

The exact position of the Observatory is

Latitude	29° 36′ 13″ south.
Longitude	2° 1′ 34″·5 east.

The height of the Observatory is 2095·674 feet above the sea; and its distance from the coast is fifty-four miles by the highroad, and forty-two miles in a direct line.

When I presented my sketch of the "Leading Features of the Climate of Natal" to the Society, it was my purpose to take some future opportunity to submit more in detail the facts upon which my deductions were based, and to draw more particular attention to certain of the peculiarities of the climate of this interesting locality which are the most deserving of further investigation.

Natal is of special interest in a meteorological point of view for this reason: it forms the very centre and focus of one of the great South African ranges of climate, and is therefore the position in which the conditions and laws of this range can be most satisfactorily and advantageously studied. South Africa is properly distributed into three ranges of climate, which are severally: —1. The Kafir range, comprising Zululand, Natal, Independent Kaffraria, British Kaffraria, and the portion of the Cape Colony lying to the south of the Stormberg and Nieuweld Mountains; 2. The Bechuana range, comprising the Orange-River Free States and the Transvaal Republic; and, 3. The Namaqua zone, comprising Namaqualand, Bushman's-land, and the Great Kalabari

Desert. Of these three zones the Kafir zone is the most fertile; and of the Kafir zone Natal is the most fertile portion.

In treating of the eight years' series of Natal meteorological observations in detail, it is convenient to consider separately certain features that can be readily classed by themselves. I therefore propose to take, upon this occasion, "The Atmospheric Pressure and Hot Wind of Natal," and upon some other occasion to allude severally to the Temperature, the Rainfall and Moisture, and the Thunderstorms.

The mean pressure of the atmosphere at my Observatory at Maritzburg, for the eight years from 1858 to 1865, derived from 2920 observations of the barometer, was 27·891 inches of the mercurial column. The highest reading of the barometer during the eight years was 28·474 inches, and the lowest reading for the same period was 27·215 inches. The extreme range of atmospheric pressure for the eight years was therefore 1·259 inch of the mercurial column. The mean yearly range of pressure during the eight years was 0·991 of an inch. It may be worth while here to recall the fact that Maritzburg is situated approximately in the 30th parallel of south latitude, and at an elevation of 2000 feet above the sea, and to contrast its mean annual range of atmospheric pressure with the mean annual range of pressure at Greenwich, which is 1·85 inch.

The barometer upon which I placed most reliance was a standard of Negretti and Zambra's, selected and examined for me by Mr. Glaisher. In using this instrument, I found it most convenient, after a little time, to fix the adjusting-screw permanently when the fiducial point was in exact contact with the column standing at 27·700 inches, and afterwards to consider 27·700 the neutral point of the instrument, and to apply the proper correction for capacity to each observation.

The height of the Observatory was determined by the mean of eighty barometric observations, taken simultaneously at the Observatory and at the Custom-House, at the Seaport of Durban. The barometer used at Durban was a Board-of-Trade marine barometer, constructed by Mr. Casella, and having the corrections for capacity applied in the divisions of the scale. The two barometers were carefully compared together, after they were fixed in their permanent positions, by the intermediate agency of a very delicate mountain barometer of Negretti and Zambra's.

There is an almost constant diurnal oscillation of the mercurial column of the barometer at Maritzburg, amounting to nearly one-tenth of an inch. The average amount, in exact numbers, is 0·078 of an inch. During the period of eight years there were only 217 days on which this diurnal oscillation was not strongly marked; that is to say, it is seen distinctly on thirteen days out of fourteen. The exceptional days are those in which the barometer is rising so rapidly, under a larger and more general influence, that the diurnal influence is more than compensated, and so masked. The diurnal oscillation is, of course, due to the direct influence of the sun's rays during each day. The atmosphere is heated and rarefied, so long as the sun shines down vigorously upon it, and condenses again as the sun's rays are withdrawn. Even on a cloudy day the effect is still produced, because the sunshine is acting upon the atmosphere above the stratum of cloud. This periodic diurnal influence in reality exerts a very considerable power over climate in regions where it is well developed, and is therefore worthy of close and careful study. In South Africa, where there are large tracts of solid ground continually stretched out under a blazing sunshine during the hours of the day, and where the same influence is as constantly withdrawn during the continuance of a not brief night, the phenomenon is necessarily well developed and remarkable. Professor Hennessy, of Dublin, drew pointed attention to this matter at the last meeting of the British Association for the Advancement of Science, at Nottingham, and intimated that it is seriously engaging his attention. He also remarked upon the advantage that Natal possesses as a field for studying the natural influence. I think it is very desirable to observe closely the conditions that attend upon the non-development of the oscillation on exceptional days; and I hope, hereafter, to be able to extend my investigations in this direction.

The mercurial column of the barometer is never stationary in Natal, even when the constant diurnal oscillations have been allowed for and abstracted from the consideration. It is continually sweeping boldly up, or boldly down, from day to day. If the most strikingly marked elevations and depressions be taken for the estimate, there were 291 great atmospheric waves during the eight years, which gives an average length of ten days for each wave. But each of these larger and bolder waves is so broken up by inferior oscillations that it is also possible, if inferior but still well-marked troughs and crests be taken, to make the enumeration for the eight years give 648 waves, averaging approximately a length of four days and a half for each wave.

Now these larger oscillations of the atmosphere are obviously due to a more extended and more general influence than mere diurnal variations of sunshine and temperature. They are brought about by the bodily, so to speak, and progressive transference of masses of air from place to place, under determining causes as yet imperfectly apprehended. But these causes, no doubt, are fundamentally underlain by the great natural distribution of the air-currents in this particular zone of the earth's latitude. There is here a general tendency of the lower regions of the atmosphere towards the north-west, under the trade-wind inclination of the air, supplemented and reinforced by the fact that the great masses of heated land lie towards the north-west, and the great space of cool ocean towards the south-east. A combined trade-wind and monsoon agency so operate in Natal that, upon an average of evenly spread and frequent observations, the wind is found to be blowing from the sea, up over the land at Maritzburg, four times out of five. But there is necessarily a prevalent compensatory set in the upper regions of the atmosphere from *the north-west.* The upper and lower strata of the air flow in antagonistic currents. Now, of these two currents, the lower comes from a cold zone of the earth, and is comparatively heavy and dense, while the upper comes from a warm zone of the earth, and is comparatively light and rare. When the two currents are at a normal, or average, relation to each other, the barometer shows a certain average or mean indication of pressure. But if this medium condition is disturbed—if one current encroaches unduly upon the other, the indication of the barometer is changed in a corresponding degree. When the upper, north-west current encroaches on the lower, the mercury goes down; when the lower, south-east current encroaches upon the upper, the mercury ascends. The successive large waves of the atmosphere in Natal, therefore, indicate that there is a constant alternating play, or action and reaction, going on in this part of the earth between the upper and lower currents, and that now one and now the other encroaches upon the condition of mean equilibrium, and predominates for the passing time.

Having thus stated my view of the proximate cause of these large atmospheric waves and of this constant disturbance, I next proceed to offer my proof that this explanation is, in the main, warranted by fact. It sometimes happens that the predominance of the one current over the other reaches an extreme degree, and that the upper current altogether displaces the lower, and actually strikes the ground, in the neighbourhood of Maritzburg.

When this takes place, a "*hot wind*" is said to be blowing there. A violent storm from the north-west blows over the land, bringing with it a temperature that rises to somewhere between 90° and 97°, and a dryness that withers the leaves of plants at a touch, and causes the timber and furniture of houses to crack with loud explosions. Now *this hot wind is invariably coincident with the troughs of the large atmospheric waves.* Whenever the hot wind blows, the barometer is at its lowest readings. There is here, then, clear and positive demonstration that it is the predominance of the upper current of the atmosphere, setting from the equatorial regions, which causes the *depression* of the mercurial column of the barometer. It is a plain and obvious inference that it is the predominance of the opposite current, coming from the higher latitudes of the south, which causes the rise of the mercury.

Science has not yet been able to explain what the exact machinery is that is employed to maintain this mighty aërial pulsation, so regular towards the tropics, although disturbed and broken in higher latitudes and colder regions, and no doubt so necessary for diffusing and removing atmospheric inequalities, and feeding the restless and beneficent battalion of the winds. But it is an interesting fact that even the greatest and most violent irregularities of this pulsation may be reduced to law, and in some degree referred to cause, if a sufficiently long period of observation of their recurrence be taken. Thus, for instance, in the case of Natal, the ultimate and extreme supremacy of the upper north-western current is marked by the hot wind. Now, to passing and casual observations, these hot winds seem to be quite accidental occurrences, and to be about as likely to present themselves at one season of the year as at another. The actual recurrence of the hot wind at Maritzburg during the several months of the year for a period of eight years is given in the appended Table, in which the numbers express the number of days on which the hot wind was found to blow:—

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1858.	2	1	4	0	0	0	2	4	4	1	2	1
1859.	1	2	1	2	1	3	2	2	7	7	3	5
1860.	1	3	0	0	3	0	0	0	3	4	1	1
1861.	0	0	0	1	1	1	2	2	4	3	3	0
1862.	1	1	0	1	3	2	4	7	8	8	4	1
1863.	2	0	0	0	1	0	4	2	5	2	3	2
1864.	3	2	0	0	0	1	2	5	6	5	5	2
1865.	2	1	1	3	1	0	3	4	4	4	3	2

A mere inspection of this Table brings out the fact that the hot wind is more frequent in the months of August, September, October, and November, and, therefore, that it is in some measure the result of a seasonal influence. But now let the average of these numbers be taken for each month, and the series then is—

Hot wind in

January	1·5 time.
February	1·2 „
March	0·7 „
April	0·9 „
May	1·2 „
June	0·9 „
July	2·4 times.
August	3·2 „
September	5·1 „
October	4·2 „
November	3·0 „
December	1·7 time.

From this series it at once becomes apparent that the hot wind of Natal is really a seasonal phenomenon, and that the influence producing it is in its highest force in the month of September, and that from this month the influence declines gradually in both directions, being at its minimum from March to June. The upper north-west current has most development in the early months of the summer, and least development in the early months of the winter. The hot wind blows at Maritzburg, upon an average, about twenty-five times a year.

In all probability a sufficiently extended and detailed series of observations would demonstrate that the great alternating oscillations of the atmosphere are due to the progressive increase and diminution of solar influence, during change of season, over large and irregularly varied tracts of the earth's surface.

The wind-vane can by no means be taken as the indication of the direction of the great atmospheric currents; it merely shows the local eddies and surface movements at the spot. The barometer is the only instrument that can tell what is actually taking place. The proof of this is very easy indeed. I have stated that my Observatory at Maritzburg is rather more than 2000 feet higher than the seaport at Durban. Now I have been at the pains on several occasions of laying down the curves of atmospheric pressure for Maritzburg and Durban simultaneously in a diagram. It is then seen that the curves are almost identical at the two places. The minor discrepancies, after the two inches for 2000 feet difference of elevation have been allowed for, are very trifling and slight indeed. The Diagram (Plate VIII.) is given to illustrate this fact; it represents the lines of atmospheric pressure for Maritzburg and Durban, for the months of September and October in the year 1865. The slight discrepancies in the variation of the atmospheric pressure at the two places are indicated in the drawing by the letter *a*. The hot wind was blowing in force at Maritzburg eight times during these two months; the exact times of its prevalence are marked by the letter H. Now upon these eight occasions the hot wind was *not* blowing at Durban. This is the usual state of affairs. When there is violent hot wind at Maritzburg and in the uplands, the current is in some other direction on the sea-coast, with considerably less impetuosity of movement, and with a many-degrees-lower temperature. The hot current seems to be effectually stopped from descending lower towards the sea-level when it arrives within a few miles of the actual sea-line, by the inflowing set from the sea, and to be compelled to glide over the lower and cooler stratum, merely deflecting its movement in some degree so as to bend it into a direction of approximate parallelism to the coast-line. Now it will be observed in the diagram that H, H, the times when the hot wind was blowing at Maritzburg without its corresponding presence at Durban, were by no means the periods when the slight discrepancies of pressure between Maritzburg and Durban were most marked. The inference is obvious. The wind-vane does not give the true indication of the movement of the general mass of the atmosphere; and it is the general movement of this mass that causes barometric depression, even in the place where the wind-vane does not show the movement to be in the direction which is necessary to the production of the effect. There is no hot wind at the sea-port of Durban, and yet the hot-wind depression of the barometer is as clearly marked there as at Maritzburg. The hot wind is blowing overhead and through the mean thickness of the aërial stratum, although it does not reach the immediate vicinity of the ground.

The hot wind is always strong: it is commonly very strong,—indeed, amounting almost to a hurricane—although it does not produce the devastation and destruction of the true hurricane, probably on account of the actual impact and momentum of the moving air in the regions where the wind prevails being considerably diminished by the expanded and comparatively rarefied state of the aeriform medium. It is always irregular and fitful, expending itself in short bursts and gusts, and sweeping dense clouds of dust with it over the country. The towns are frequently enveloped in the dust-storm for considerable periods. At present I have entirely failed in getting any estimate, that I can present as of any value, of its force, although I have constantly had my attention drawn to the high desirability of securing measures of its velocity and power. Its capriciousness and fitfulness have hitherto made it quite unmanageable with the instruments I had at command, or with the appliances I could contrive under the constant pressure and strain of more important and imperative duties. Since, however, inspecting Mr. Browning's pressure-plate, recently exhibited at a meeting of the Society, I see daylight under the clouds in this direction, and hope on some future occasion to have a better account to render on this point to the Meteorological Society.

The dryness of the hot wind of Natal is very remarkable and very constant: this is, of course, due to the fact that the wind comes sweeping along from the broad tropical surfaces of the arid African continent. It is, indeed, primarily fed from the great equatorial upcast that deposits its moisture in the tropical rains, as it rises, and then turns over to flow back towards the higher latitudes above. On the western margin of the African continent the same wind is occasionally experienced; but there it is neither so hot nor so dry, because its course lies over wide stretches of the Atlantic, instead of over wide stretches of heated tableland and deserts.

To render my exposition of this very interesting matter as complete as possible, I give beneath a statement of the temperatures, and hygrometric conditions of the atmosphere, at Maritzburg during the occurrence of the most decidedly marked hot winds of two years, 1860 and 1861:—

	Dry-bulb Thermometer.	Wet-bulb Thermometer.	Degree of Humidity.
1860.	°	°	
May 4...............	74·5	61	44
May 29	80·5	61	32
September 3	70	60	53
September 7	87·5	67	32
September 15......	81	63	36
September 16......	85·5	63	28
October 7	82	70·5	52
October 13.........	79	68	53
1861.			
April 3	84·5	69	42
May 11	75	59	38
May 12	76	63	46
June 20	68·5	54·5	41
July 20	73	51·5	25
July 30	80·5	57·5	26
August 5	66	56	52
September 3	77·5	61·5	39
September 12......	82·5	64	34
September 26......	84	63	30
September 27......	82	63	33
October 5	85	61·5	26
October 30.........	86·5	69	37
November 13......	84·5	69	42
November 28......	69	54	28
December 29......	85	70	43

The influence of change of wind in immediately altering the moisture of the air is strikingly shown in the records of September 8, 1860. A hot wind was blowing from north-west at 9 in the morning, with the temperature standing at 70°, and the degree of moisture at 53. At 3 in the afternoon the wind was blowing with equal violence from the south-east, and the temperature was still 70°. But the moisture was then, although at the hotter period of the day, 73.

The conditions of the air during the prevalence of hot wind in Natal are occasionally beyond the degrees provided for in Glaisher's Tables. Thus, for instance, on the 20th of September in the year 1862, a hot wind was blowing at Maritzburg with the dry-bulb thermometer standing at 88°, and the wet-bulb at 61°·5. This gives about 20 for the moisture. The highest temperature I registered during eight years occurred during the prevalence of a hot wind on the 30th of December 1865. The temperature was 97°·6. I did not get the readings of the wet- and dry-bulb thermometers until 3 in the afternoon, when the temperature had fallen to 91° and the wet-bulb thermometer stood at 72°, giving 30 for the amount of moisture: a thunderstorm had then commenced. It may be necessary here to remark that the estimate of moisture was taken at the ordinary times of reading the instruments, and not specially at the instant of highest temperature. I have always intended to make a special series of observations, with some instrument of greater delicacy than the ordinary wet- and dry-bulb thermometers, for determining the extreme degrees of dryness during the South-African sirocco, but have not yet been able to carry my purpose into effect.

The temperature of the hot wind in Natal is highest during the season of summer; but the dryness is greater with the hot winds of the winter than with the hot winds of the summer. This, no doubt, is one principal reason why thunderstorms almost constantly attend upon the hot winds in summer, and do not as constantly in the winter season.

The hot wind almost always begins to blow in the very early morning, about daybreak or before, and continues in force until the middle of the day, or early afternoon. It then lulls suddenly, and immediately afterwards a strong, cool, sea wind from the south-east sets in, and the thermometer falls many degrees. The thermometer very rarely rises above 85° even in the midst of the summer season, unless a hot wind is blowing. It then mounts to somewhere between 85° and 97°, according to its force and continuance. In midwinter the hot wind sometimes blows unmistakeably, without raising the temperature to 85°; but this is rare. It occasionally happens that the hot wind intermits in the afternoon, but returns in the morning, for two or three days in succession. The reason for the hot wind beginning to blow in the late night, or early morning, and ceasing to blow in the afternoon is obvious. In the late night and early morning the monsoon influence (which brings the sea-breeze in steadily to the land) is at its least, in consequence of the land being then most cooled by radiation, and is therefore most readily conquered by its fitful and boisterous antagonist. In the afternoon, on the other hand, the monsoon influence is at its most, on account of the strong upcast engendered over the heated land, and therefore the most able to contend with success against the antagonistic current.

It has been already remarked that the hot winds of Natal seem to be intimately connected with the north-west gales of the South Atlantic. The storm of the 17th of May 1865, in which the mail-steamer 'Athens' was wrecked in Table Bay, within a few hours of the time when a fierce hot wind, with the lowest trough of a great atmospheric wave, burst upon Natal, is spoken of at page 208 of the 'Proceedings' of the Meteorological Society for 1866. I have there stated my impression that the South-African hot winds are great predominant atmospheric currents, capable of generating cyclones at their margins where they come into contact with strong antagonistic streams, rather than cyclones themselves. On the particular occasion of the storm of the 17th of May 1865, however, the character of the atmospheric movements was more than usually cyclonic at Natal; and the phenomenon was altogether so interesting that I think it worth while to place its leading features on record, in the form of a diagram, for future reference (fig. 2).

The upper line represents the curves of atmospheric pressure at Maritzburg for the time, showing a broad triangle, or depression, extending through twelve days. The storm (*st*) at Table Bay happened twenty hours before the greatest depression of the mercury at Maritzburg, which occurred with a fierce hot wind (H), there having also been a hot wind (H′) blowing at Maritzburg the afternoon and evening before the storm. It is worthy of note how rapidly and abruptly the mercury rose after the storm. The lower line shows the corresponding range of daily maximum temperature for the same period. The barometric and thermometric lines, taken together, leave no doubt that a current from the north was gaining more and more power during the approach of the storm, with which it culminated with the lowest depression of the mercury and highest range of temperature, and that a current from the south came into play immediately afterwards, and gained more and more ascendancy until the next atmospheric wave was at its crest on the morning of the 22nd. The series of arrows beneath show that the great disturbance began with a south-east, and ended with a south wind, and that the acme of the disturbance was marked by a burst of north-west wind, broken by a brief interval in which the wind veered from north-west, through south-west, east, and south-east, back to north-west. The wind was continually shifting on the other days immediately preceding and following the storm; but it will be noticed how constantly it was from the south-east *in the evening*, excepting just before the crisis of the storm.

The thunderstorms of the summer generally occur in the troughs of the great atmospheric waves. The rain falls with both the lowest and highest positions of the barometer. The rainfall of low pressure takes place during, or in connexion with, thunderstorms; the rainfall of high pressure in connexion with sea-gales.

It must be understood that, in speaking of waves and undulations of the atmosphere in this paper, I merely adopt a phraseology that is convenient for expressing what I have to say regarding the great movements and changes of condition of the atmosphere; I by no means intend to commit myself to the view that there are necessarily waves of the atmosphere analogous to the surface-waves of the sea. Whether or not there be such waves, the representation of the varying pressures upon the mercury of the barometer, by lines drawn in the wave-form upon paper, is alike intelligible to the eye and to the mind.

The following Table gives the mean, the highest, and the lowest barometric pressures at Maritzburg, at an elevation of 2095·674 feet above the sea, for the eight years extending from 1858 to 1865:—

Barometric pressure in inches of mercury.

	Mean.	Highest.	Lowest.
	in.	in.	in.
1858.	27·786	28·304	27·215
1859.	27·863	28·474	27·415
1860.	27·920	28·393	27·429
1861.	27·920	28·393	27·392
1862.	27·876	28·401	27·419
1863.	27·924	28·362	27·369
1864.	27·922	28·423	27·470
1865.	27·934	28·431	27·542

The following Table gives the mean pressure, for each of the same eight years, at 9 in the morning, 3 in the afternoon, and 9 in the evening.

	At 9 A.M.	At 3 P.M.	At 9 P.M.
	in.	in.	in.
1858.	27·809	27·678	27·830
1859.	27·909	27·839	27·914
1860.	27·941	27·867	27·946
1861.	27·946	27·869	27·955
1862.	27·899	27·819	27·912
1863.	27·934	27·861	27·942
1864.	27·954	27·861	27·953
1865.	27·958	27·883	27·961

CXXXVII. *On the Earth-Current and Telegraphic Currents.* By Professor LAMONT. Translated by W. T. LYNN, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich*.

THAT in telegraphic communications, and wires extended for telegraphic purposes (that is, insulated in their course and united with the earth at both ends), electric currents continually exist, of different direction and strength, has already been known for twenty years; and repeated investigations have even been made of these currents; but whoever wishes to obtain from the published observations on this subject a view of the results arrived at will find that this is no easy task. At first the phenomenon was referred to the province of terrestrial magnetism, and great hopes were entertained of what might be accomplished in this way, which hopes, however, have hitherto failed of fulfilment. At present it appears pretty clearly established that atmospheric circumstances are here more effective in their operation; and so far the investigation would fall under the head of meteorology; there are even physicists who suppose there is some connexion with the changes of weather, and who therefore expect to derive in this way benefit to meteorology.

I do not, indeed, share in this opinion, but recognize the importance of the questions connected therewith, and believe that they therefore deserve a more detailed consideration in a meteorological periodical.

Ampère, led by theoretical considerations, was the first to prove that an electrical current circulating round the earth was capable of explaining the phenomena of terrestrial magnetism; this it is which has since received the name of earth-current.

From the first the earth-current had only a theoretical existence. But scarcely had the existence of electrical currents been recognized in telegraphical communications when it was conceived that the earth-current had really and in fact been detected—and this so much the more as it was remarked that, with extraordinary currents in the telegraphic wires, magnetic disturbances synchronously occurred.

Barlow first undertook the more accurate investigation of the currents daily taking place in telegraphic wires. He placed a declination-needle near the galvanometer, and found that between the telegraphic currents and the magnetic movements absolutely no connexion was to be traced.

---

* Extracted from vol. ii. no. 1 of the 'Memoirs' of the Austrian Meteorological Society.

It follows from this that the currents usually existing in telegraphic communications (whose most essential property it is to produce magnetic variations) are quite distinct from the earth-current; and I consequently propose hereinafter to call them telegraphic currents. The introduction of this special nomenclature is fully justified by the result of the investigations which I undertook in the year 1859, and which have led to the discovery of the actual earth-current*; for it followed from them that, if we make use of sensitive galvanometers and (which can only be done for short intervals of time) compensate the part of the current arising from chemical and thermal influences, the small residual motions, rapidly succeeding one another, agree with the simultaneous magnetic variations *in the strictest manner and to the smallest detail*; it also resulted that the earth-current propagates itself on the earth's surface independently of the irregularities of the surface, and that in parallel directions precisely the same motions of current take place.

The earth-current exists, therefore, as well as the telegraphic currents, but, in proportion to them, is faint and has the property that only its *changes* make themselves apparent through the wires, whilst the current itself moves in the earth (whose resistance to conduction is, in proportion to the wire, evanescently small).

Indeed, in contradiction to these results, some physicists have been unwilling to recognize any essential difference between the earth-current and the telegraphic currents, and have endeavoured to bring the telegraphic currents into connexion with the magnetism of the earth by showing an agreement between the *mean* daily variations of the telegraphic currents and the *mean* magnetic movements. Some very weighty objections, however, as I believe, may be adduced not only against the agreement of the numbers, but also against the assumptions on which they are founded. In particular, it should be remembered that, if the telegraphic currents, as is here supposed, were derived from the earth-current, all their variations would be proportional to the changes of the earth-current; and consequently an agreement between the motions of the current and the magnetic variations ought to become apparent, not *merely* in the *mean values*, but also in the *smallest detail.*

---

* A complete account of the experiments may be found in my work, 'The Earth-Current and its connexion with the Magnetism of the Earth,' Leipsic, 1862.

It is, however, not necessary to enter on the present occasion into a closer investigation of the relations here indicated, as the proper earth-current undoubtedly belongs to the department of terrestrial magnetism, and can in no way be used for the purposes of meteorology; otherwise it would connect itself, as I indicated at the outset, with the telegraphic currents; and these I will now discuss more in detail. For this purpose there is already at hand tolerably comprehensive material, to which Messrs. Barlow and Walker in England*, MM. Matteucci and Secchi in Italy, M. Dufour in Switzerland, and, anterior to these, von Baumgärtner in Austria have made the most important contributions; and we are thus furnished with determinations concerning the *daily period* of direction and the *strength* of the telegraphic currents.

If we consider, in the first place, the daily period, we find that it results from the observations that such a period exists everywhere, but shows itself as a different one. In a north-and-south line, Mr. Barlow found a period agreeing tolerably nearly with the increase and decrease of the temperature of the air; but whereas, according to him, a minimum makes its appearance at Derby in the morning, according to the observations of M. Matteucci a maximum occurred at Turin about the same time of the day. On the whole, the Turin observations give four turning-points—two maxima (at about the time of sunrise and sunset), and two minima (midday and midnight). From this, on the other hand, the observations of P. Secchi, at Rome, differ completely; in particular we find, if we compare the morning and midday turning-points, a maximum at one place whilst there was a minimum at others. From my own observations (in which a shorter series was used) there results indeed a daily period, but one which on serene days obeys a completely different law from that on cloudy days; whilst the succession on rainy days differs from both of these. All this relates to wire connexions extended in the north-and-south direction; whilst for east-and-west communications, quite as little harmony in general prevails.

As to the direction of the currents, there are places where they proceed constantly from south to north (Turin), other places where they go from north to south (Rome), and, again, other places where the direction is reversed in the course of the day (Lausanne, Greenwich, &c.); and von Baumgärtner has even shown the existence of cases where parts divided from the same line showed directions of the current opposed to each other.

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* The photographic registering-apparatus of telegraphic currents, set up by Mr. Airy, at Greenwich, promises important results; but hitherto some intimations on the subject are all that have been published.

The mean strength of the current is very different in different places; and in the same directions of the lines there arise proportionally very strong and very weak currents, of which the observations of Messrs. Barlow and Walker furnish the most remarkable proofs.

From the great difference which everywhere manifests itself in regard to the daily period in the direction and strength of the currents, it seems to follow that they must be affected, if not wholly, yet in by far the greatest proportion, by local causes and conditions—an important proposition, inasmuch as, according to this, we should have to give up the hope of being able to arrive at conclusions, from the observation of the telegraphic currents, concerning external or general atmospheric conditions or occurrences.

The local causes which have hitherto been taken into account may be divided into three categories: to the first belong the oxidation and polarization of the earth-levels; in the second would have to be included all possibly existing thermo-electric influences; whilst the different presumptive movements of the electricity extending over the earth's surface will form the the third category.

Of course the first category does not fall within the department of meteorological inquiry, and therefore will not be discussed here any further.

The most important category I consider to be the second; and I have the conviction that by far the greatest part of telegraphic currents hitherto observed will be referred to thermal influences. The condition of the origin of thermo-electric currents is a chain consisting of dissimilar material; for we meet with unequal or variable temperature, and both conditions, in telegraphic connexions: the wire and the ground-lines and the ground itself, which forms a part of the chain, are heterogeneous substances; and earth and air have continually different and variable temperatures; even the ground in and of itself would have, if we were willing to consider the wire only as a conductor, inequality of matter and temperature to such a degree that the origin of a thermal current could be explained*.

---

* This is a provisional view, against the admission of which different doubts might be brought forward. A decision can only be attained by experimental

There yet remains the third category of local causes—namely, the motions of the electricity. The electricity of the earth is, without doubt, an important factor in atmospheric changes; and if the telegraphic currents could give any information concerning the electric conditions, this would be of course an important gain for meteorology. But here also we come upon very difficult questions. In the first place, it ought to be known what the electricity brings into motion and continually keeps in motion. Next, it has been conjectured, on the ground of the experiments undertaken by Colladon, that by the telegraphic wires electricity passes continually out of the earth and into the earth, or in the reverse direction, in sufficient quantity to produce a permanent galvanometric deflexion; I have, however, shown by experiment, so early as the year 1861, the untenable nature of this supposition; in fact, such a passage of electricity does by no means take place excepting in thunder-showers; and on this point M. Matteucci also has since then furnished satisfactory proof.

The attention of M. Matteucci has been directed in his experiments to another very remarkable circumstance which may be mentioned here; that is to say, he found that if there was a difference of level in the ground, the current moved in all cases from the lower to the higher levels, and therefore from the less to the greater electrical diffusion. From this there might be deduced, in isolated cases, an explanation of the telegraphic currents—not, however, without the introduction of a special hypothesis, since, under ordinary circumstances, the difference of diffusion would have as its consequence only an instantaneous compensation, not a continuous current. If we wish to ascribe the telegraphic currents to the electricity of the earth, it must be necessary to assume that, by means of the communication of the solar heat, or of some occurrence connected with the rotation of the earth*,

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means; and experiments appear here to be so much the more indispensable as the theory of thermo-electric currents at present received leaves much yet to be desired in completeness and certainty. I began, some time ago, to undertake some experiments with chains consisting of wire and wet clay, but cannot yet say with certainty how far results may be expected from the further prosecution of the same. The contrivances which M. Matteucci has hit upon in his experiments on telegraphic currents, in order to prevent the arising of thermo-electric currents, relate only to wire communications; he regards the earth, if I do not mistake, as a body which has, in this case, merely to absorb the electricity.

* I, for my part, suppose (provisionally only, as an hypothesis for investigation) that the sun possesses a great quantity of positive, the earth, on the other hand, a very considerable quantity of negative electricity, so that on the earth's surface a

or by atmospheric differences of condition, a continuous motion of the electricity is produced with local modifications. If I mistake not, there are several physicists who incline to this view, and consider as probable a constant or an occasional gradual transferring of electricity from one point of the earth to another. Of course, on this supposition, the earth-currents would acquire an especial importance to meteorology; meantime there are as yet so few reliable points to lead to a decision upon the hypothesis, that it would answer no purpose to enter into a more detailed discussion.

Having thus, in what precedes, mentioned a number of characteristic observations and views of physicists in regard to the telegraphic currents, it remains for me in conclusion to sum up the general result of the foregoing labours. But I must declare to my regret that the precise result cannot be furnished; the whole investigation continues in an incoherent and fragmentary condition. All that has hitherto been accomplished belongs to the head of preparatory works, and has properly only had the effect of bringing the investigation to a stand-point at which hopeful prospects open themselves out; but its prosecution must be looked upon as profitable and well worthy of the labour involved.

The defining of this stand-point and the suggestion of new observations and experiments was the sole aim of the present paper.

---

negative-electrical tide-wave (analogous with the tide of the sea) is produced; but I thus explain only the proper earth-current, which depends little or not at all upon local conditions. Mr. Lloyd appears to wish to refer the telegraphic currents (which, according to him, would be only indications of the earth-current) to a similar cause, as he considers probable an accumulation of electricity on the side of the earth which is turned towards the sun.

To the Editor.

2 Parliament Street, S.W.,
1866, October 17.

ENCLOSED is a rule for finding heights by the aneroid, which, I believe, you will find sufficiently accurate for any height less than 10,000 feet, although neither tables, logarithms, nor rule of three are required.

I am,
Dear Sir,
Yours truly,
G. HARVEY SIMMONDS.

RULE.

Multiply 26,300 by the difference between the readings of the aneroid, and divide the product by half the sum of the readings; the quotient will be the height uncorrected for temperature. To find the correction depending on the temperature:—Multiply the difference between 32 and half the sum of the temperatures at the lower and upper stations by 2·3 and by the *number of thousands of feet* in the uncorrected height. The product will be the correction, which must be added to or subtracted from the uncorrected height, according as half the sum of the temperatures is greater or less than 32.

ERRATA.

Page 318, seventeenth line from top, *for* barometer *read* bar; and in the eighteenth line from top, *for* bar. *read* bar

Page 328, paper CXXXII., *for* Dr. Trestel *read* Dr. Prestel *wherever it occurs.*

Fig. 1.

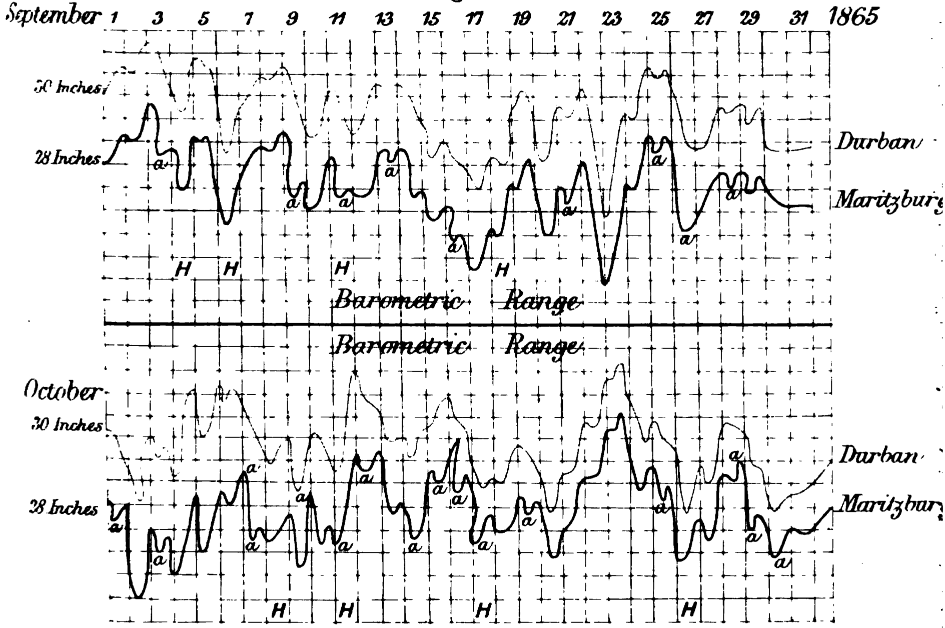
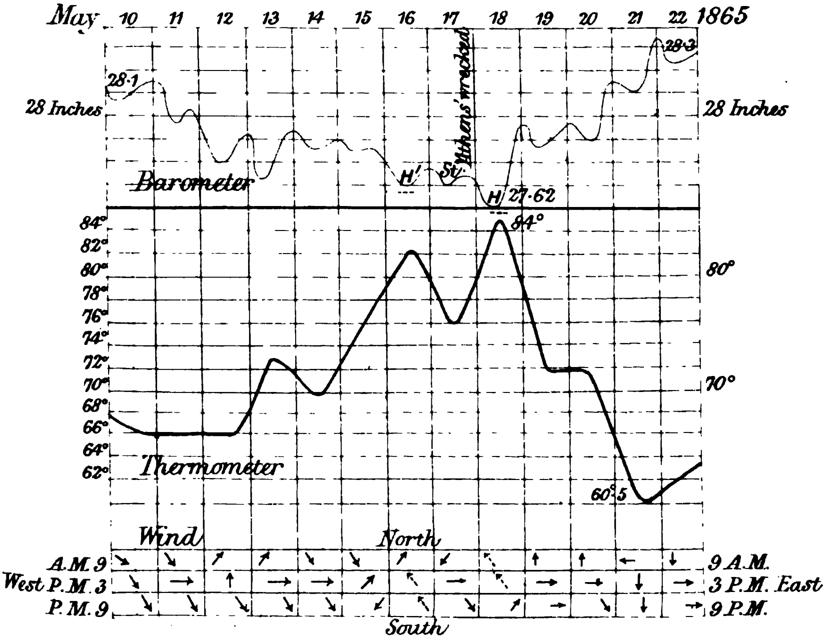

September
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
1865
30 Inches
28 Inches
Durban
Maritzburg
a
H
Barometric Range
Barometric Range
October
30 Inches
28 Inches
Durban
Maritzburg
a
H

Fig. 2.


May
10
11
12
13
14
15
16
17
18
19
20
21
22
1865
28·1
28·3
28 Inches
28 Inches
Barometer
H'
St. John's wrecked
H
27·62
84°
84°
82°
80°
78°
76°
74°
72°
70°
68°
66°
64°
62°
80°
70°
Thermometer
60°5
Wind
North
A.M. 9
West P.M. 3
P.M. 9
South
9 A.M.
3 P.M. East
9 P.M.

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Vol. III.] [No. 30.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, Esq., F.R.S., Secretary.

1867, MARCH 20.

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JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. III. 1867, MARCH 20. [No. 30.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

Alexander W. Bickerton, Esq., 25 Cattle's Grove, Nechell's Green, Birmingham;
Captain Arthur Harrison, R.A., Secretary Royal Artillery Institution, Woolwich;
Robert James Mann, Esq., M.D., 12 Cecil Street, Strand;
Major J. F. Tennant, R.E., F.R.A.S., R.G.S., 22 Henrietta Street, Cavendish Square;

were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society were read.

CXXXVIII. *The Influence of the Moon on the Direction of the Wind.* By James Glaisher, Esq., F.R.S., Secretary.

The influence of the moon on the direction of the wind has not yet, so far as I know, been investigated. The anemometrical records at the Royal Observatory, Greenwich, afford ample means for such an investigation, Osler's self-registering anemometer having been in constant action since November 1840, thus affording instrumental determination of the direction of the wind at all hours of the day and night.

In the investigation of which I am about to speak, I have confined myself to the first seven years of these records, or from the lunation in November 1840 to the last lunation in the year 1847.

The first step in the work was to extract the days of new moon within the period.

The next step was to form in each year a Table whose first column contained the days of new moon in that year, with seventeen additional columns, one for each of the sixteen points of the compass, and one for calm hours.

The third step was to enter under each direction of the wind its duration in hours on every day of new moon.

The fourth step was to take the sums of the numbers under each direction, and the sum of all the numbers irrespective of direction; which sums, if no observations had been lost in the lunation, should equal the number of lunations, multiplied by 24: this agreement served as a check upon the accuracy of the work in every Table.

The Table on the opposite page is a specimen of one of these Tables.

The next step was to form a Table of the days when the moon was one day old, two days, &c. to twenty-nine days old, and every one of these Tables was treated in the same way as that on page 361; thus was formed above 200 Tables.

The sums in every year, of the numbers on every day of the moon's age, were then collected, and in this way the Tables on pages 362 to 371 were formed.

TABLE showing the Number of Hours the Wind blew from the sixteen points of the Azimuthal Circle, on every day of New Moon in the Year 1842.

Days of New Moon.	Number of Hours the Wind blew from																Calm.
	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
1842.																	
January 11......	...	...	...	...	...	...	...	...	16	2	...	...	...	...	...	...	6
February 10 ...	...	...	...	...	...	...	...	...	2	14	8	...	...	...	...	...	...
March 12	...	...	...	...	...	...	...	...	...	8	4	6	2	...	2	...	2
April 10.........	...	...	...	4	18	2	...	...	...	...	...	...	...	...	...	...	...
May 10	...	...	...	...	...	...	...	2	...	4	4	6	6	2	...	...	...
June 8	...	6	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July 8	...	...	...	...	...	...	...	...	2	8	4	2	8	...	...	...	...
August 6.........	...	...	...	...	...	...	...	...	...	2	6	8	...	...	...	...	8
September 4 ...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	20
October 4	16	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
November 2 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24
December 2 ...	...	...	...	...	...	...	...	...	10	10	...	...	...	...	...	...	4
December 31 ...	...	...	...	...	...	...	...	...	...	...	...	2	18	...	4	...	...
Sums 13	16	10	18	4	18	2	...	2	30	48	30	24	34	2	6	...	68

TABLES showing the Number of Hours the

Moon's Age.	Year.	Number of Lunations.	Number of Hours the							
			N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
Day of New Moon.	1841.	13	6	2	16	10	14	...	...	...
	1842.	13	16	10	18	4	18	2	...	2
	1843.	12	26	16	14	...	10	...	...	...
	1844.	12	56	4	4	2	4	...	...	...
	1845.	11	...	18	26	8	28	...	...	...
	1846.	12	28	...	...	8	2	4	...	...
	1847.	12	14	2	6	10	4	...	...	2
1 day.	1841.	14	6	4	28	16	14	...	...	4
	1842.	12	...	2	26	20	2	4	2	12
	1843.	13	28	...	4	14	8	...	...	...
	1844.	12	40	24	10	2	...	...	4	...
	1845.	11	18	24	18	10	16	...	...	...
	1846.	12	36	2	...	2	8	...	...	4
	1847.	12	12	2	...	2	6	...	...	6
2 days.	1841.	13	10	6	14	12	10	8	...	2
	1842.	12	22	10	24	12	...	...	6	6
	1843.	13	22	8	...	20	8	...	...	...
	1844.	12	26	30	4	...	4	4	...	2
	1845.	11	32	18	6	6	2	2	2	...
	1846.	12	38	6	4	2	6	8	...	4
	1847.	12	14	2	...	...	6	10	4	18
3 days.	1841.	14	14	10	2	...	...	6	...	4
	1842.	12	8	24	14	2	12	...	16	8
	1843.	13	28	...	2	6	16	...	...	...
	1844.	12	22	20	...	2	12	4	...	...
	1845.	11	20	12	12	...	...	...	...	16
	1846.	12	20	22	2	...	8	...	2	4
	1847.	12	...	...	16	8	8	...	...	12
4 days.	1841.	13	18	...	...	...	22	4	...	4
	1842.	12	16	6	14	6	10	6	2	...
	1843.	13	...	8	2	4	2	2	4	6
	1844.	12	22	6	10	8	28	4	...	...
	1845.	11	38	12	10	6	16	6	2	6
	1846.	13	20	16	6	2	6	...	...	4
	1847.	11	12	10	20	8	20	...	2	6
5 days.	1841.	14	10	4	18	16	24	...	2	8
	1842.	12	16	4	36	10	6	12	2	8
	1843.	13	12	...	...	...	...	4	...	2
	1844.	12	28	2	10	2	18	...	...	...
	1845.	11	26	18	18	36	10	4	...	2
	1846.	12	...	14	16	...	...	...	...	...
	1847.	12	40	4	12	10	8	...	2	10

Wind blew in different Directions.

Wind blew from								Calm.	Total Number of Hours.
S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
24	30	52	56	32	4	2	4	60	312
30	48	30	24	34	2	6	...	68	312
30	28	38	36	6	...	2	...	82	288
32	32	24	28	34	8	8	4	38	278
10	42	16	22	2	2	18	6	56	254
20	30	32	64	2	4	4	12	66	276
48	50	42	52	18	12	...	12	16	288
28	26	70	28	14	4	14	14	62	332
22	40	40	20	4	4	8	...	82	288
22	32	58	30	6	8	8	36	58	312
24	18	12	28	30	16	22	10	48	288
10	52	10	...	2	2	12	10	80	264
30	22	44	18	10	...	10	14	78	278
64	52	30	50	12	...	...	6	46	288
16	22	56	22	12	10	4	10	98	312
28	52	32	12	8	...	2	16	58	288
8	32	58	50	10	6	16	24	50	312
20	22	34	22	26	10	10	16	58	288
42	32	10	14	2	...	...	4	92	264
8	32	22	38	16	6	2	14	82	288
44	50	42	22	10	...	2	...	64	288
26	46	42	38	16	...	2	14	116	336
22	40	32	20	8	...	...	22	60	288
22	26	38	44	16	...	...	8	106	312
12	30	42	20	20	10	6	6	82	288
22	18	22	32	10	10	4	14	72	264
40	26	22	42	24	...	...	...	76	288
54	58	40	24	6	2	2	10	48	288
14	44	56	44	14	4	4	...	84	312
16	8	58	22	8	8	2	10	96	288
18	26	38	30	6	10	2	16	138	312
20	18	32	36	16	6	18	10	50	284
...	18	4	34	24	6	12	10	56	260
10	52	52	56	4	6	2	...	52	288
48	44	14	28	6	4	4	6	32	264
8	20	40	34	26	12	24	12	54	312
4	18	60	38	8	8	10	6	52	288
22	42	44	28	4	2	...	38	104	312
22	18	60	26	18	10	4	6	64	288
20	16	8	20	12	8	...	2	50	250
10	46	28	32	16	6	6	14	64	252
46	32	28	36	14	...	2	8	26	278

TABLES showing the Number of Hours the

Moon's Age.	Year.	Number of Lunations.	Number of Hours the							
			N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
6 days.	1841.	14	30	4	18	12	16	...	10	10
	1842.	12	12	8	20	12	4	...	...	...
	1843.	13	14	...	2	14	2	...	4	4
	1844.	12	24	16	16	10	16	...	...	...
	1845.	11	4	22	6	10	6	2	4	4
	1846.	12	2	...	18	6	26	2	4	...
	1847.	12	22	16	4	8	32	8	4	2
7 days.	1841.	14	16	12	6	8	14	2	...	4
	1842.	12	12	18	30	2	6	2	...	2
	1843.	13	10	...	6	6	...	...	...	...
	1844.	12	24	20	6	16	8	...	2	2
	1845.	11	22	12	14	4	4	2	2	6
	1846.	12	16	2	12	14	14	8	...	...
	1847.	12	16	8	22	8	20	4	...	...
8 days.	1841.	14	16	4	2	2	2	...	6	14
	1842.	12	28	12	26	6	14	6	...	...
	1843.	13	26	8	2	8	4	...	2	4
	1844.	12	10	8	20	6	12	2	2	2
	1845.	11	22	8	10	6	...	4	...	...
	1846.	13	10	18	2	16	18	2	...	6
	1847.	12	38	20	2	4	18	16	...	2
9 days.	1841.	14	20	...	12	2	10	...	4	...
	1842.	12	38	12	18	4	36	6	10	16
	1843.	13	8	...	20	4	6	...	...	...
	1844.	12	58	20	28	8	12	...	...	...
	1845.	11	34	20	10	2	...	...	...	2
	1846.	13	24	4	8	4	16	...	...	...
	1847.	12	8	6	10	8	18	12	4	18
10 days.	1841.	14	18	...	6	12	10	...	...	2
	1842.	12	14	...	16	4	24	4	8	10
	1843.	13	22	18	20	16	4	...	...	...
	1844.	12	38	28	38	6	12	4	...	...
	1845.	11	52	24	6	4	4	...	2	6
	1846.	13	10	6	2	...	2	4	...	4
	1847.	12	30	...	...	10	10	4	...	...
11 days.	1841.	13	2	...	16	4	...	...	...	...
	1842.	12	8	12	14	20	26	2	4	12
	1843.	12	14	18	20	2	4	...	...	...
	1844.	13	16	32	42	20	4	2	...	...
	1845.	11	24	26	4	6	4	4	...	2
	1846.	13	30	4	...	6	8	2	...	4
	1847.	12	6	...	2	8	4	2	2	4

Wind blew in different Directions (*continued*).

Wind blew from								Calm.	Total Number of Hours.
S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
26	40	42	14	34	2	...	16	62	336
2	10	48	28	34	4	2	6	98	288
14	46	30	26	12	4	6	20	114	312
6	12	76	18	40	4	8	...	42	288
16	32	10	18	16	...	22	4	76	252
10	50	48	14	2	10	2	6	78	278
46	16	34	30	38	4	4	2	18	288
24	36	30	38	42	12	6	26	60	336
2	6	28	28	24	4	6	6	112	288
20	32	46	46	8	...	10	14	114	312
2	12	28	48	20	22	22	4	50	286
54	18	4	32	12	4	12	4	48	254
24	52	34	26	4	...	...	2	80	288
46	18	38	60	14	4	...	...	20	278
20	28	36	46	20	8	20	12	100	336
10	2	22	14	4	2	8	30	104	288
6	12	42	52	24	6	6	12	98	312
6	32	80	30	2	4	...	...	72	288
24	12	16	34	28	26	10	10	52	262
6	36	28	34	6	4	...	12	104	302
58	38	22	34	12	6	4	4	10	288
26	48	56	22	32	12	2	22	68	336
14	16	6	2	8	...	...	4	98	288
16	14	34	54	30	14	4	6	102	312
...	32	20	12	12	6	4	4	72	288
42	16	8	20	18	4	22	18	48	364
16	26	36	30	14	2	2	14	114	310
56	32	28	22	24	6	2	6	28	288
8	30	46	40	36	6	26	24	72	336
4	28	30	22	8	...	4	...	112	288
18	30	16	34	30	2	2	14	86	312
2	18	26	20	14	2	2	4	74	288
38	6	4	10	12	8	12	12	64	264
28	22	30	48	20	2	6	22	106	312
46	76	52	38	...	...	2	...	20	288
4	16	56	68	52	10	4	4	76	312
42	22	34	14	2	...	2	...	74	288
12	4	30	40	20	...	2	4	118	288
12	10	20	34	26	22	12	8	50	310
24	2	2	18	6	2	2	10	104	240
14	18	12	46	6	4	...	22	136	312
60	44	50	44	34	6	4	...	18	288

TABLES showing the Number of Hours the

Moon's Age.	Year.	Number of Lunations.	Number of Hours the							
			N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
12 days.	1841.	14	22	10	2	6	12	...	...	4
	1842.	12	18	...	14	4	18	6	8	10
	1843.	12	22	2	10	8	2	...	...	...
	1844.	13	30	28	34	24	24	2	..	..
	1845.	11	46	20	6	6	2	...	...	...
	1846.	13	24	8	2	...	...	6	2	2
	1847.	12	32	4	...	10	16	4	2	16
13 days.	1841.	14	42	6	2	12	12	8	6	...
	1842.	12	8	2	...	2	12	4	8	16
	1843.	12	32	4	10	10	4	...	4	2
	1844.	13	36	30	14	26	20	8	...	...
	1845.	10	30	10	4	2	14	...	...	...
	1846.	13	14	8	4	2	4	2	2	8
	1847.	12	28	12	26	26	12	2	...	8
14 days.	1841.	14	22	22	8	24	2	8	4	4
	1842.	12	20	4	16	...	12	6	10	4
	1843.	12	60	18	4	4	32	...	...	2
	1844.	13	38	14	16	22	30	6	...	4
	1845.	10	40	2	2	4	4	...	...	...
	1846.	12	30	4	4	4	4	2	16	10
	1847.	13	68	22	18	2	2	8	4	6
15 days.	1841.	14	18	6	...	24	10	6	16	8
	1842.	12	2	8	12	12	8	2	8	2
	1843.	12	28	20	4	6	10	2	...	...
	1844.	13	12	10	18	32	20	8	4	...
	1845.	10	22	12	8	4	10	...	...	...
	1846.	12	4	4	...	6	10	4	20	10
	1847,	13	64	24	8	20	18	8	4	6
16 days.	1841.	14	34	6	...	12	16	4	...	2
	1842.	12	8	2	18	...	6	...	2	2
	1843.	12	42	...	4	2	...	...	...	...
	1844.	13	30	20	24	10	24	10	6	2
	1845.	10	34	22	12	12	12	2	...	...
	1846.	12	...	...	...	2	...	...	8	6
	1847.	13	60	20	6	8	20	...	4	4
17 days.	1841.	14	36	4	4	22	18	...	...	4
	1842.	12	10	2	14	...	14	...	...	...
	1843.	12	32	14	10	14	14	...	...	2
	1844.	13	46	16	6	4	14	10	8	4
	1845.	10	22	12	16	6	14	...	...	6
	1846.	12	8	...	...	2	18	...	2	...
	1847.	13	58	34	10	22	6	2	4	26

Wind blew in different Directions (*continued*).

Wind blew from								Calm.	Total Number of Hours.
S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
30	34	42	66	22	4	4	8	70	336
46	14	24	6	10	2	...	...	84	264
6	8	14	26	26	10	6	14	134	288
2	6	8	16	14	16	26	20	52	302
8	4	6	8	6	2	8	24	88	234
32	14	30	6	10	10	...	6	160	312
48	30	42	42	6	...	2	4	20	288
50	30	32	26	12	4	6	6	82	336
50	20	36	12	4	2	10	14	88	288
2	20	54	26	...	4	12	8	96	288
16	6	22	14	18	6	14	12	70	312
2	30	10	30	12	2	10	24	60	240
10	18	20	14	12	...	14	18	152	302
26	20	32	42	24	6	...	4	20	288
38	38	24	12	30	10	6	4	80	336
34	20	42	24	10	8	4	14	60	288
4	18	42	28	10	4	...	4	58	288
6	8	32	8	8	...	2	30	88	312
12	54	10	28	10	2	12	4	56	240
24	8	20	22	14	2	2	2	120	288
22	44	36	26	22	4	6	6	16	312
16	48	60	36	20	...	12	8	48	336
22	20	46	28	16	2	12	6	82	288
...	2	18	44	22	8	4	4	116	288
2	20	38	18	6	...	28	20	76	312
6	46	14	14	16	4	2	8	74	240
28	6	22	22	6	4	14	...	128	288
10	16	54	32	14	10	18	6	...	312
26	28	36	32	22	2	10	8	98	336
20	24	58	30	14	...	...	...	104	288
4	...	20	22	18	2	18	10	146	288
16	4	34	32	18	...	8	14	60	312
12	30	16	18	4	4	10	4	48	240
24	54	32	18	...	2	...	14	128	288
34	26	48	36	20	4	6	10	6	312
18	54	34	10	14	2	14	8	94	336
14	38	72	36	18	...	6	4	60	288
4	2	6	12	14	6	6	6	146	288
22	10	4	30	20	2	2	12	90	300
8	24	16	48	14	...	...	6	48	240
32	26	36	38	8	...	...	14	104	288
30	40	20	10	12	10	12	...	16	312

TABLES showing the Number of Hours the

Moon's Age.	Year.	Number of Lunations.	Number of Hours the							
			N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
18 days.	1841.	13	30	14	16	4	18	8	6	10
	1842.	12	14	2	22	2	16	...	8	8
	1843.	12	8	24	28	40	20	...	...	...
	1844.	12	40	4	14	...	22	6	12	10
	1845.	10	24	6	14	8	6	2	...	...
	1846.	12	4	...	2	22	8	...	...	...
	1847.	13	108	18	18	4	12	...	...	16
19 days.	1841.	14	40	14	...	...	8	14	8	8
	1842.	12	6	4	26	4	10	2	...	4
	1843.	12	24	10	34	16	22	4	...	...
	1844.	13	14	6	24	22	54	8	8	8
	1845.	10	16	8	...	2	2	2	...	...
	1846.	12	18	...	12	18	14	10	2	2
	1847.	13	56	38	30	14	28	10	2	2
20 days.	1841.	13	38	4	4	6	32	...	6	26
	1842.	13	16	...	20	16	16	...	6	6
	1843.	12	4	6	14	54	38	8	...	...
	1844.	13	14	14	26	10	22	...	...	4
	1845.	11	18	8	...	...	...	...	...	...
	1846.	12	30	10	8	8	38	14	2	...
	1847.	13	48	14	...	4	22	14	2	4
21 days.	1841.	13	28	4	10	8	24	6	2	10
	1842.	13	60	16	12	8	...	...	...	4
	1843.	12	2	16	14	8	34	10	6	6
	1844.	13	24	12	32	16	24	8	2	2
	1845.	10	34	4	4	10	2	...	...	...
	1846.	12	14	6	18	16	12	6	4	6
	1847.	13	44	10	12	10	22	6	12	4
22 days.	1841.	13	30	4	12	8	6	...	6	10
	1842.	13	38	20	40	12	8	6	2	4
	1843.	12	26	6	6	...	6	...	...	...
	1844.	13	20	10	22	14	28	2	...	10
	1845.	10	24	6	4	10	4	14	8	2
	1846.	12	20	16	22	10	...	...	...	6
	1847.	13	66	8	4	2	10	8	8	16
23 days.	1841.	13	28	2	6	4	10	4	2	2
	1842.	13	82	20	12	...	6	2	...	2
	1843.	12	2	2	4	10	8	4	6	2
	1844.	12	32	16	14	...	2	...	...	4
	1845.	11	34	2	14	8	4	14	4	...
	1846.	12	12	24	26	8	10	2	2	2
	1847.	13	46	6	4	8	2	8	6	12

Wind blew in different Directions (*continued*).

Wind blew from								Calm.	Total Number of Hours.
S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
26	28	18	26	10	4	2	18	74	312
...	16	44	60	26	2	14	6	48	288
2	2	12	8	6	...	...	10	128	288
6	...	18	20	10	...	2	14	110	288
...	8	30	46	44	10	10	4	28	240
2	16	36	30	10	6	18	14	112	280
28	16	8	12	20	14	6	22	10	312
16	28	20	32	28	8	6	18	64	312
8	20	42	32	26	10	18	4	72	288
2	2	2	16	10	6	...	...	140	288
24	10	34	14	2	...	...	...	74	302
30	14	26	44	28	4	...	...	64	240
2	24	32	14	12	6	...	10	102	278
10	16	20	38	16	4	2	8	28	312
14	30	22	34	12	6	6	6	66	312
2	18	56	48	18	8	12	...	70	312
2	4	8	6	18	...	2	...	124	288
8	20	54	28	22	8	4	12	66	312
26	36	24	66	20	...	20	2	28	248
10	12	20	6	10	...	...	8	112	288
26	20	32	34	22	16	8	16	30	312
10	52	28	16	12	...	...	16	86	312
8	6	50	40	24	4	20	14	46	312
4	4	12	18	2	...	4	4	144	288
...	20	40	36	12	...	4	10	70	312
14	16	4	22	14	12	6	6	86	234
12	28	2	8	6	10	8	12	120	288
26	24	34	36	20	16	8	18	10	312
44	36	40	30	18	10	4	22	32	312
6	16	38	62	...	...	...	10	50	312
14	10	4	8	8	2	10	6	182	288
22	22	30	32	24	2	8	12	54	312
32	16	28	10	...	...	...	8	64	230
26	10	8	16	8	6	6	4	108	266
36	16	48	18	28	12	4	12	16	312
50	34	56	32	26	...	...	32	24	312
10	10	32	56	8	8	6	18	40	312
16	6	26	40	16	2	6	2	136	288
2	10	50	32	20	14	4	52	36	288
8	10	38	28	8	2	...	30	60	264
16	30	6	6	10	2	6	26	74	262
38	56	34	52	12	...	4	16	8	312

TABLES showing the Number of Hours the

Moon's Age.	Year.	Number of Lunations.	Number of Hours the							
			N.	N.N.E.	N.E.	E.NE.	E.	E.S.E.	S.E.	E.S.E.
24 days.	1841.	13	12	2	8	...	18	4	2	12
	1842.	13	44	2	10	6	6	4	6	2
	1843.	12	24	2	6	22	18	...	...	2
	1844.	12	22	16	18	16	...	2	...	...
	1845.	11	40	16	8	8	6	...	...	...
	1846.	12	24	26	8	16	2	6	...	...
	1847.	13	40	...	...	8	2	14	...	6
25 days.	1841.	12	2	...	8	4	22	2	4	8
	1842.	13	10	14	20	26	14	2	10	4
	1843.	12	20	4	12	46	8	...	...	...
	1844.	12	22	10	20	6	6	4	...	...
	1845.	11	48	16	6	4	6	...	...	...
	1846.	12	2	2	4	4	2	6	...	...
	1847.	12	22	...	2	10	12	4	2	2
26 days.	1841.	12	4	4	6	4	2	...	...	2
	1842.	13	12	6	48	8	8	...	...	2
	1843.	12	14	14	24	28	...	...	...	4
	1844.	12	20	10	8	6	...	2	...	...
	1845.	11	28	6	14	6	2	...	...	6
	1846.	12	6	8	...	4	14	6	8	8
	1847.	12	14	10	...	8	...	...	2	2
27 days.	1841.	13	14	6	10	4	2	2	14	18
	1842.	13	18	14	8	14	14	4	...	6
	1843.	12	14	22	12	22	6	2	4	...
	1844.	12	22	2	...	2	24	8	12	14
	1845.	11	20	10	8	8	12	4	...	4
	1846.	12	...	6	6	18	16	8	2	4
	1847.	12	...	8	4	...	...	...	...	4
28 days.	1841.	13	16	...	...	2	30	...	...	...
	1842.	13	8	6	4	12	16	8	2	...
	1843.	12	12	16	20	16	22	4	...	...
	1844.	12	24	10	24	8	18	2	...	2
	1845.	10	16	8	14	18	14	...	...	...
	1846.	12	...	8	6	4	6	4	2	6
	1847.	12	6	16	6	...	...	...	...	2
29 days.	1841.	6	8	2	4	...	8	...	2	6
	1842.	7	6	...	2	...	...	...	...	4
	1843.	7	22	6	4	...	...	...	...	4
	1844.	6	14	8	12	8	...	...	...	...
	1845.	5	12	...	4	12	10	...	...	...
	1846.	7	8	...	...	...	..	...	...	2
	1847.	6	10	10	6	10	2	...	...	...

Wind blew in different Directions (*continued*).

Wind blew from								Calm.	Total Number of Hours.
S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
44	42	54	30	20	8	....	14	42	312
2	8	52	22	34	4	8	2	100	312
10	16	10	30	16	2	4	4	122	288
8	12	46	34	16	10	20	24	44	288
12	34	22	28	16	...	4	26	44	264
32	30	24	20	4	...	...	10	76	278
16	60	30	32	30	4	4	10	48	304
30	38	50	22	32	2	4	6	54	288
24	20	26	14	12	2	14	20	80	312
6	18	16	32	20	...	10	14	82	288
2	2	20	38	30	10	4	12	102	288
14	8	36	20	34	4	2	8	50	256
18	62	50	6	6	4	6	6	110	288
20	30	32	32	30	8	16	12	54	288
40	24	74	24	28	12	8	6	50	288
40	36	38	30	10	...	...	...	74	312
8	14	22	44	8	4	4	...	100	288
30	16	18	24	18	4	2	4	126	288
6	26	62	48	4	...	...	2	34	244
40	64	22	16	...	...	...	...	84	280
28	30	50	44	20	8	8	14	50	288
36	10	58	32	30	8	8	8	52	312
10	14	60	56	22	4	2	2	64	312
16	26	22	44	12	2	8	4	72	288
16	32	26	26	14	4	4	10	62	278
12	14	66	46	...	...	...	6	28	238
6	58	20	32	4	...	...	16	92	288
58	36	70	50	10	4	8	4	32	288
44	42	42	22	26	2	8	4	74	312
...	8	18	82	38	12	12	...	86	312
10	20	20	30	16	6	4	10	82	288
28	34	14	24	60	10	4	6	10	278
14	20	38	20	14	2	...	10	52	240
22	42	36	18	6	6	...	4	104	274
62	32	52	30	10	6	4	16	46	288
14	30	12	18	2	8	...	...	30	144
26	22	26	10	8	2	4	2	56	168
8	12	12	42	2	...	...	...	56	168
8	12	28	8	6	2	6	10	22	144
4	...	2	18	12	...	...	8	38	120
12	10	16	44	12	6	2	6	50	168
24	38	14	14	6	...	...	...	10	144

The sums of the numbers under each direction of the wind for every day of the moon's age were then taken, and thus was formed the next Table.

TABLE showing the Number of Hours the wind blew in each direction on every day of the Moon's Age as found from all the Observations made at the Royal Observatory, Greenwich, from 1840, November, to 1847, December.

Moon's Age in Days.	Number of Lunations.	Number of Hours the Wind blew from the																Calm.	Total Number of Hours.
		N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.		
0	85	146	52	84	42	80	6	0	4	194	260	234	282	128	32	40	38	386	2008
1	86	140	58	86	66	54	4	6	26	200	242	264	174	78	34	74	90	454	2050
2	85	164	80	52	52	36	32	12	32	166	242	254	180	84	32	36	84	502	2040
3	86	112	88	48	18	56	10	18	44	198	244	238	220	100	22	14	74	560	2064
4	85	126	58	62	34	104	22	10	26	126	210	254	250	78	44	44	52	508	2008
5	86	132	46	110	74	66	20	6	30	132	192	268	214	98	46	46	86	414	1980
6	86	108	66	84	72	102	12	26	20	120	206	288	148	176	28	44	54	488	2042
7	86	116	72	96	58	66	18	4	14	172	174	208	278	124	46	56	56	484	2042
8	87	150	78	64	48	68	30	10	28	130	160	246	244	96	56	48	80	540	2076
9	87	190	62	106	32	98	18	18	36	170	184	188	162	138	44	36	74	530	2086
10	87	184	76	88	52	66	16	10	22	144	210	204	212	120	20	54	76	534	2088
11	86	100	92	98	66	50	12	6	22	168	116	204	264	146	44	26	48	576	2038
12	87	194	72	68	58	74	18	12	32	172	110	166	170	104	44	46	76	608	2024
13	86	190	72	60	80	78	24	20	34	156	144	206	164	82	24	66	86	568	2054
14	86	278	86	68	60	86	30	34	30	140	190	206	148	104	30	32	64	478	2064
15	86	150	84	50	104	86	30	52	26	84	158	252	194	100	28	62	80	524	2064
16	86	208	70	64	46	78	16	20	26	136	166	244	188	96	14	52	60	590	2064
17	86	212	82	60	70	98	12	14	42	128	194	188	184	100	20	40	50	558	2052
18	84	228	68	114	80	102	16	26	44	64	86	166	202	126	36	52	88	510	2008
19	86	174	80	116	76	138	50	20	24	92	114	176	190	122	38	26	40	544	2020
20	87	168	56	72	98	168	36	16	40	88	140	216	222	122	38	52	44	496	2072
21	86	206	68	102	76	118	36	26	32	74	150	170	176	90	42	50	80	562	2058
22	86	224	70	110	56	62	30	24	48	180	126	196	176	86	32	32	74	506	2032
23	86	236	72	80	38	42	34	20	24	140	156	242	246	100	28	26	176	378	2038
24	86	206	64	58	76	52	30	8	22	124	202	238	196	136	28	40	90	476	2046
25	84	126	46	72	100	70	18	16	14	114	178	230	164	164	30	56	78	532	2008
26	84	98	58	100	64	26	8	10	24	192	210	286	236	88	28	22	26	518	1988
27	85	88	68	48	68	74	28	32	50	154	190	322	286	92	22	30	50	402	2004
28	84	82	64	74	60	106	18	4	10	180	198	220	226	170	44	32	50	454	1992
29	44	80	26	32	30	20	0	2	16	96	124	110	154	48	18	12	26	262	1056

By comparing the numbers in this Table together, the general prevalence of those winds compounded of the S. and W. are evident; that direction of the wind under which the next largest numbers appear is N.; and the next in order below is S.

By considering the numbers under each direction of the wind separately, we find that the N. wind has been the least prevalent towards the end of the lunation, and the next in order for a few days at the beginning; and it has been the most prevalent when the moon has been between nine days and twenty-four days old, the hours of the duration of the north wind during this period often exceeding the number of hours of duration of any other direction, and greatly exceeding those from the south, particularly between the fourteenth and twenty-fourth days, when the number of hours of north wind is the double of those of the south wind.

The N.N.E. and N.E. winds are nearly alike; the number of hours of duration are generally small, the largest numbers in both cases appear a few days before and after full moon.

The E.N.E. has the largest numbers on the days following full moon; on all other days the numbers are small, and there is not much difference between them.

The east wind has the greatest consecutive numbers from the 18th to the 21st days of the moon's age; these are followed by small numbers; the smallest three consecutive numbers are on the day of new moon and following days.

The E.S.E.:—

The numbers under this heading are generally small; the largest consecutive numbers are those on the 20th, 21st, 22nd, and 23rd days of the moon's age.

The S.E.:—

On the days of new moon there was no instance of wind blowing from this direction in the seven years. The hours of its duration in the days at the beginning and towards the end of the lunation are generally very small; the largest number is about full moon, and the next in order of duration are those following the days of full moon and continuing till the 23rd day.

The S.S.E.:—

The duration of this wind, though somewhat more than that of the S.E., is still limited. The largest consecutive numbers are those when the moon is 21, 22, and 23 days old. The day of new moon is the smallest number of any.

The South wind:—

There is a very marked difference in the hours of duration of this wind at different parts of the lunation, the numbers at the beginning and towards the end of the lunation being much larger than those about full moon; and they exhibit a great contrast to the north wind, which is most frequent at the times when the south is the least so.

The S.S.W:—

The numbers under this direction also show decided differences. The largest appear about the beginning and towards the end of the lunation, and they are the smallest in the period when the moon is from seven days to twenty-three days old, the number of hours of its continuance in this period being only about one-third of those in the remainder of the lunation.

The S.W. wind:—

The most continuous large numbers appear under this direction than in any other. The same marked difference at the different ages of the moon appear, and of like character to those shown with the S. and S.S.W. winds, the duration of the wind being much longer in the first and last weeks of the lunation than in those of the weeks preceding and following full moon.

The W.S.W. wind:—

The order of the numbers under this direction differs from that shown in the three preceding columns; they differ but little among themselves. The largest consecutive numbers appear towards the end of the lunation.

The West wind:—

The duration of this wind is much less than those of the compounds of S. and W., and is very evenly distributed throughout the lunation; like the W.S.W. wind, its largest consecutive numbers are towards the end of the lunation.

The W.N.W. and N.W. winds:—

The duration of these winds seems to be pretty equally distributed throughout the lunation.

The N.N.W. wind:—

The three largest consecutive numbers under this direction appear at the 23rd, 24th, and 25th days; but the difference throughout the lunation is small.

Calms:—

In these there appears a very decided difference at the different ages of the moon. The smallest number appears at the beginning of the lunation, the longest series of large numbers from the 9th day to the 17th, and then declining to a minimum at the end of the lunation.

By dividing the numbers in the preceding Table into four groups of seven days each, the first consisting of the day of new moon to the 6th day; the second, the 7th to the 13th day; the third, the 14th to the 20th; and the last, the 21st to the 27th day; and taking the sums in each group, the next Table was formed. The sums when the moon was 28 and 29 days old being taken together, forming a number corresponding to one day and a half at the end of the lunation.

Moon's Age.	Number of Days.	Number of Hours the Wind blew from—																Calm.
		N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
days ys 0 to 6	7	928	448	526	358	498	106	78	182	1136	1596	1800	1468	742	238	298	478	3310
7 to 13	7	1124	524	580	394	500	136	80	188	1112	1098	1422	1494	810	278	332	496	3840
14 to 20	7	1418	526	544	534	756	190	182	222	732	1048	1448	1328	770	204	316	426	3700
21 to 27	7	1184	446	570	478	444	184	136	214	978	1212	1684	1474	756	210	256	574	3374
28 and 29	1½	162	90	106	90	126	18	6	26	276	322	330	380	218	62	44	76	716

The North wind:—

The number in the first week of the lunation is the smallest of any, and the largest appear in the third week.

N.N.E.:—

The smallest number under this heading appears in the first and fourth weeks, and are nearly alike, and the largest in the second and third also nearly alike.

N.E.:—

The smallest number appears in the first week, the largest in the second, again small in the third, and large in the fourth week.

E.N.E.:—

The smallest number appears in the first week, and the largest in the third.

E.:—

The largest number appears in the third week, and the smallest in the fourth.

E.S.E.:—

The smallest number appears in the first week, and the largest in the third week.

S.E. and S.S.E.:—

The numbers in the first and second weeks are smaller than those in the third and fourth.

S.:—

The largest number appears in the first week, and the smallest in the third.

S.S.W. and S.W.:—

The largest number appears in the first week; the next in order is the fourth week; the smallest numbers in the second and third week.

W.S.W.:—

The smallest number is in the third week, in each of the other three weeks the numbers are nearly alike.

W.:—

The smallest number is in the first and fourth week, and the largest in the second and third.

W.N.W.:—

The largest number is in the second week, and the smallest in the third.

N.W.:—

The largest number is in the second week, and the smallest in the fourth.

Showing the Number of Hours Daily in each Week of the Moon's Age in eighty-six Lunations.

Moon's Age.	Number of Hours the Wind blew from—																Calm.
	N.	N.N.E.	N.E	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
1st week..............	132	64	75	51	71	15	11	26	162	228	257	209	106	34	42	68	473
2nd week	160	75	83	56	71	19	11	27	159	157	203	213	116	40	47	71	549
3rd week	203	75	78	76	108	27	26	32	105	150	207	190	110	29	45	61	529
4th week..............	169	64	81	68	63	26	19	31	140	173	241	211	108	30	37	82	482
28th and 29th days	108	60	71	60	84	12	4	17	184	215	220	253	145	41	29	51	477

The numbers in this Table show very clearly the relative duration of each wind at different ages of the moon, and the relative duration of one direction compared with another.

N.N.W.:—

The smallest number appears in the third week, and the largest in the fourth.

Calms:—

The greatest number of calms appear in the second week; somewhat less number in the third, still less in the fourth, and least in the first week.

From the discussion of the observations in these seven years, it seems that, when the sun and moon were in and near conjunction, the air was less frequently calm; the duration of the north wind with its east compounds, were less frequent; the south wind with its west compounds, were more frequent than when the sun and moon were in and near opposition. From this it would seem that the position of the moon in respect to the sun has exercised an influence on the direction of the wind in these years.

By taking the sum of the numbers in each direction of the wind, we find—

The	S.E.	continued	482	hours.
	E.S.E.	”	634	”
	S.S.E.	”	832	”
	W.N.W.	”	992	”
	N.W.	”	1,246	”
	E.N.E.	”	1,956	”
	N.N.E.	”	2,034	”
	N.N.W.	”	2,050	”
	E.	”	2,226	”
	N.E.	”	2,326	”
	W.	”	3,236	”
	S.	”	4,234	”
	N.	”	4,816	”
	S.S.W.	”	5,276	”
	W.S.W.	”	6,144	”
	S.W.	”	6,684	”
	Calm	”	14,942	”

And these numbers show the relative frequency of each wind in these years.

CXXXIX. *On the Phenomena of Meteors.*

By E. T. Loseby, Esq.

In considering the subject of meteors, with a view to arrive at a satisfactory solution of the phenomena exhibited, the following objections have presented themselves against the generally received theory, which supposes that the body of the meteor is ignited by the compression and friction of the air, and wholly or partly consumed in its passage:—

1st. If the luminosity were due to ignition from the compression or friction of the air, it would be necessary that the air should remain tolerably constant in its density, and not vary greatly at the different elevations at which meteors appear. But meteors are recorded to have been measured at more than 100 miles high, and to have presented no marked difference of appearance from those that have been measured at less than thirty miles high. Now, the difference between the rarity of the air at twenty-eight miles and at 105 miles high, is more than 1000 millions of times; and it therefore appears impossible that the air can be instrumental in causing a luminosity which, at whatever elevation it is seen, presents but little difference in appearance.

This objection applies equally to any theory which supposes the luminosity to be due to the passage of the meteor through a phosphorescent or hydrogenic atmosphere, because both phosphorus and hydrogen possess weight; and any gas that is ponderable and compressible, and we know of none that are not, would present the same relative difference of rarity, between the upper and lower strata, that obtains in atmospheric air.

To assist in realizing this vast difference of density, it may be mentioned that the finest air-pump will only rarefy to the extent of 1500 times; whereas air at 105 miles high is 1073 millions of times thinner than at the earth's surface; and it is therefore 700 thousand times less dense than the most perfect vacuum which an air-pump can produce. Yet the rarity produced by the air-pump is within one fifteen-hundredth of a perfect vacuum, and may be practically regarded as one, for the short time a meteor remains under the influence of the atmosphere; because although the numbers show there is theoretically an infinite space between the air-pump rarity and the perfect vacuum, yet the difference is but trifling if the rarity of 1500 times be compared with the amount of change it has already undergone from the full density.

It may here be mentioned that the rule employed in this paper for ascertaining the density of the atmosphere at different elevations is that which assumes that, taking the elevations from the surface of the earth in the arithmetical series of 7, 14, 21, &c., the density will diminish in the geometrical series of 4, 16, 64, &c. This rule, known as Mariotte's and Cotte's, assumes that the temperature is constant, which is not the case; and therefore a correction would be required agreeing with the law of decrease of temperature, if greater accuracy were necessary; but the difference of rarity due to the entire effect of temperature is much too small to reverse any of the conclusions arrived at; and therefore the smaller difference due to the rate of change in the temperature at different elevations, may be neglected as unimportant in the present inquiry.

2nd. In order to arrive at the amount of resistance offered by the atmosphere, and the quantity of heat that would ensue from the passage of a meteor through the upper regions, it may be convenient to compare it with the known resistance and heat encountered by a projectile in its flight through the air at the earth's surface. Assuming, on the one hand, the height of a meteor to be 105 miles, and the rarity of the air at this height to be 1073 millions of times greater than at the earth's surface, and the rate of its flight to be thirty miles a second; and, on the other hand, the velocity of a projectile to be 132 times less than that of the meteor; it will only be necessary to square the difference of velocity, and employ it to divide the difference of rarity, to obtain a direct comparison of the resistance offered to the meteor. The result is, that the resistance offered by the air to the meteor is sixty-one thousand times less than that offered to the projectile. Yet neither the cannon-ball nor the leaden bullet fuse by their passage through the air; nor is the heat during flight sufficient to fire the fulminating powder contained within them, when used as shells; and in the case of those rifle-shells which are stopped with wax at the front end, the wax is not melted; proving that the heat of the ounce-shell during flight, including that received from the powder at starting, does not amount to 150° F. Neither is the heat greatly augmented even when the projectile is instantly stopped; for bullets after striking an iron target do not burn the fingers on taking them up, although the lead has undergone so much *instantaneous* friction that a large portion of it is distributed in splashes and the rest flattened out on the target. When meteoric stones have been stopped by friction on the earth, operating through longer intervals than that of instantaneous impact, the heat produced may have been sufficient to render the whole palpably hot; and this agrees with the evidence of meteoric stones being generally hot immediately after falling; but in some cases it may be that they have been intensely cold, because the sensation of touching an intensely cold body is said to resemble that of handling a hot one, and the association of heat with meteoric stones in the popular mind, would naturally cause the effect to be attributed to heat rather than to cold. So far from heat being generated in the atmosphere, it does not seem probable that if a meteoric stone, moving at thirty miles a second, or even at a much less speed, were to come already heated to incandescence into the atmosphere, that the heat could be maintained, because the volume traversed, and the high capacity of rarefied air for heat, would cool the body very rapidly. We know that at the surface of the earth, where the capacity of the air for heat is much less in proportion to its density, that a current of air must be comparatively very slow to maintain combustion; that no flame will exist in a stream of air moving at the rate of 50 feet a second, and that in a current of cold air moving at 100 feet a second, a red-hot body may be very effectually cooled.

3rd. Under the combustion theory, the burning of coal-gas has been taken as a standard for comparing the amount of matter consumed in the meteor. Coal-gas may therefore be taken for estimating the amount of oxygen that would be required for its combustion. Different qualities of gas consume different quantities of oxygen, volume for volume, and we will therefore take the mean, which will be about 1½ cubic foot of oxygen for each cubic foot of gas. Take the case of a meteor estimated as equal to 19 cubic feet consumed in the second of time which it lasted. This would require 27 cubic feet of oxygen, which would be diluted with about four times its volume of nitrogen in the atmosphere, making the volume at the surface of the earth 135 cubic feet. But, at seventy miles high, this would expand into 135 millions of cubic feet and at 105 miles high the volume would expand into 144,855 millions of cubic feet. Now, in order that the meteor should be consumed, it would be necessary that its surface should come into contact with each portion of these immense volumes, at their respective elevations, and extract all the oxygen from them during the second or two which the meteor lasted. Nineteen cubic feet of gas would weigh about 6600 grains; and in the condensed form of coal the superficies of a meteor composed of it would be less than half a square foot; and it would therefore have to travel through a track of 25,000 miles long at seventy miles high; and through a track of fifty-four millions of miles, at 105 miles high, before it could meet with the requisite quantity of oxygen to entirely consume it; whereas the track measured by actual observation is generally found to be less than 100 miles long. If it were possible for the meteor to become volatilized before combustion, this difficulty would be diminished in one respect, because on the solid matter being converted into gas at these elevations, the gas would spring into equally gigantic proportions; and the track, becoming wider, would be proportionably shortened. But this sudden rarefaction would cause an intense degree of cold, which, in addition to the naturally low temperature of these regions, would oppose a bar to combustion in this direction. Moreover, the meteoric stones which have reached the earth are not composed of easily volatilized hydrocarbonates, but of substances which would require, in most cases, much greater heat to change them into vapour than simply to raise them to incandescence; and it has already been shown in the case of projectiles, which encounter sixty-one thousand times more resistance from the atmosphere than does a meteor 105 miles high, that the heat, unaccompanied by combustion, is not sufficient to melt wax.

When meteors break into fragments, and are said to explode, it may be owing to their traversing a low stratum of the atmosphere, where the air is sufficiently dense to oppose a greater resistance than the cohesive materials of the meteoric stones will bear. If this be so, it would afford a ready means of approximately estimating the limit of the height of such meteors as break up. At elevations below twenty miles, the atmosphere would be sufficiently dense to overcome the cohesion of many of the meteoric stones which have reached the earth, if meeting it with a velocity of thirty miles a second.

All substances require an appreciable interval to enable them to unite with oxygen in the process of combustion; and solid bodies require as much longer time than gaseous, as is necessary to convert the solid into gas; and any of the substances of which meteorites are composed would require a much longer time to consume a pound of the material, than the second or two during which the meteor remains visible.

The black oxidized crust, and apparently burnt exterior, which meteoric stones exhibit, are generally accepted as proof of combustion having taken place during their passage to the earth;

but, suppose it were established beyond doubt that the meteorites have undergone heat, the fact would not prove that the heat has been recent. For aught we know, it may have occurred at a period equally remote with the igneous epoch of our planet; of which geology yet fails to furnish a scale sufficiently vast to determine the interval.

4th. Apart from the foregoing, the subjoined facts, elicited by Sir H. Davy in experimenting on combustion in rarefied air, may be directly applied to the subject of meteors, and it will be seen they furnish inductive evidence which would alone be fatal to the combustion theory. In these experiments, inflammable bodies were admitted under a large receiver of an air-pump, and they ceased to burn, as follows: sulphur, when the air was rarefied 20 times; hydrogen, when the air was rarefied 13 times; olefiant gas, when rarefied 11 times; alcohol and wax-taper, when rarefied 8 times; light carburetted hydrogen, when rarefied 4 times; and a mixture of oxygen and hydrogen ceased to explode when rarefied 18 times. The experiments show that the most inflammable of these bodies, sulphur, would not burn at fifteen miles high; that the least inflammable, carburetted hydrogen, or coal-gas, would be extinguished below seven miles high; and that not one of them would continue to burn at fifteen miles high, even though they remained in a perfect calm, and had no heat dissipated by the velocity at which meteors move.

Another experiment in pneumatics may be adduced, as an instance in which the necessary quantity of oxygen for combustion is contained in the body itself, condensed in a solid form:—If the highly inflammable compound, gunpowder, be confined in a gun, it ignites very rapidly; but the combustion becomes slower when freely exposed to the open air; and if the pressure of the atmosphere be removed by a vacuum, and the resulting nitrogen and carbonic acid gases are free to expand to their limit, so much heat is lost by the rarefaction that combustion is then greatly retarded—as gunpowder may be sprinkled on a red-hot iron, in the partial vacuum of a common air-pump, without exploding, and the grains will then only ignite singly, and some time will be required to consume a quantity if the vacuum be maintained by withdrawing the gases as fast as they are formed. At a height, therefore, of thirty miles gunpowder would not ignite rapidly enough to correspond with the transient period of a meteor.

Seeing that the combustion theory fails under each of the foregoing objections, and that any theory will also fail which attributes the luminosity to the passage of the meteor through any medium possessing weight, the author has, therefore, come to the conclusion that the luminosity can only be due to the meteoric stone in its passage exciting the *electricity* which envelopes the earth, as does the atmosphere. This element does not possess any weight that can be detected in the finest balance, and it may therefore remain comparatively uniform throughout its height, from the surface of the earth to the limit it extends to; and, being without weight, the limit may be far more sharply defined than the limit of the atmosphere can be.

CXL. *On the November Shower of Meteors.*

By Herr Pihl, Christiania.

In the early part of November, I received (enclosed in the 'Monthly Notices') a circular addressed to the Fellows of the Royal Astronomical Society, requesting them to watch for the expected return of the November meteoric shower,—and accordingly I watched, in company with a friend, on the night between the 12th and 13th; but the sky was dull and partly cloudy,—at 2 o'clock it became altogether thick, with a gale of wind and some rain,—yet the clouds occasionally divided a little; but no meteors at all were seen. There had, however, early in the evening been observed a fireball, and likewise one on the 10th of November, both having the appearance common to the greater number of the fireballs on the 13th–14th of November, viz. yellow of colour, and leaving a long line of sparks behind.

On the evening of the 13th there were seen at least two fireballs before 8 o'clock; but the sky was altogether not favourable for observations until about half-past 11 o'clock, at which time another fireball was seen, which in the course of about twelve minutes was followed by three others. While preparing for commencing regular observations, six other meteors were seen to traverse the sky in the course of a quarter of an hour.

We commenced our observations at about 12 o'clock, with the intention of fixing as exactly as possible the time and the points of appearance and disappearance of conspicuous objects, which afterwards might happen to be identified as having been observed at distant stations. During the first fifteen minutes, seven meteors were seen; but hardly any of them were observed with sufficient accuracy to be of any use in case of identification for determination of their parallax; and at this time it became evident that it would be entirely useless to make any observations at all with this view,—because the number of meteors increased fast, and it became therefore hopeless to expect that any distinct one under these circumstances should happen to be observed at different stations. Our only plan was, consequently, merely to count the meteors, and note down anything remarkable as to size, colour, and the like.

The number of meteors thus seen between—

h m		h m			
12 13	to	12 20	was on the average	0·4	per minute for each individual.
		27	” ” ”	0·6	” ” ”
		28	” ” ”	1·0	” ” ”
		38	” ” ”	0·9	” ” ”
		43	” ” ”	1·5	” ” ”
		45	” ” ”	1·5	” ” ”
		49·5	” ” ”	1·6	” ” ”
		57	” ” ”	2·6	” ” ”
		1 0	” ” ”	5·5	” ” ”

All Christiania mean time.

A row of trees limited our view somewhat, and we therefore removed to another part of the garden, in which we stood where we had a freer view. While doing this, another friend, Professor Esmark, of the University, came over to us, and we now agreed to take each a different quarter of the heavens, far apart from each other. The results then obtained were, for each individual per minute, on an average:—

	h m		h m			
From	1 11·5	to	1 14·5	....	6·3	meteors.
			16	....	5·8	”
			19	....	7·4	”
			22	....	8·5	”
			25	....	15·0	”
			28	....	13·4	”
			31	....	15·2	”
			37	....	23·0	”
			38	....	30·0	”
			43	....	28·9	”
			46	....	33·4	”

But the shower now increased rapidly, and was distributed over every part of the heavens; we therefore placed ourselves at an angle of about 120° with each other, so as to avoid as much as possible that more than one should observe the same meteor. The counting then gave, from $1^h\ 59^m$ to $2^h\ 1^m$(=2 minutes on the average for each individual per minute), 62·83 meteors, observed by—

Esmark	162
Homann	93
Pihl	122
	377

Mr. Homann wore spectacles, and his angle of vision is therefore less than that of both the others; and this is probably the main reason of his seeing a less number throughout the evening. Esmark, who constantly observed the greatest number, is long sighted; I am short sighted.

The scene was now most imposing; at the beginning of the shower, while the constellation of Leo was yet low above the horizon, it had been concealed behind banks of clouds, and the meteors seemed to rush in different directions from the same place in the horizon, like rockets; but now that Leo had risen higher, and the clouds became dissolved, they were seen to stream from the same point of convergence in all possible directions,—vertically up towards the zenith, and down towards the earth,—towards east and towards the west, sometimes 2, 3, 4 at the same instant. In turning towards the west the view was grand indeed; and owing to the apparent greater parallelism here of the courses of the meteors, as well as the greater duration which, as a rule, those fireballs had which seemed to ignite at a greater distance from the point of convergence (near, or even past the meridian), it gave to the whole a great likeness to a fall of snow in a gale of wind.

Some meteors were seen within or about the Sickle of Leo, having only slight angular motion until their extinction,—their course evidently being almost parallel to the line of vision. The colour was generally yellow with long streaks of sparks behind them, which often lasted long; one such train of sparks was seen during 34 seconds, rather strongly luminous, and was not extinct after that time. But the colour of others was green; and from such ones it frequently appeared as if a red fireball was expelled, which continued the course while the green one vanished. The finest of the meteors observed had a very intense bluish light and an unusual size, which, though smaller, could best be compared with that of the moon.

After about a quarter of an hour, during which no change could be observed in the density of the meteoric swarm, and before a fresh counting was commenced, they began sensibly to decrease; the air became rapidly dull, and a good many small clouds were formed, so that counting at this time would give no reliable result; it could only be clearly perceived that the density of the meteors was really decreasing. The air, however, continued to get hazy, and a counting from 2^h 49^m till 2^h 52^m gave only 66; and a fresh counting from 2^h 53^m–2^h 56^m gave only 4·9 meteors per minute for each observer. But owing to the state of the atmosphere, this result gives by no means a correct expression of the number which must at this time really have passed; it must have been considerably greater. It became continually more cloudy, and at 4–5 o'clock the whole sky was covered.

As to the mean point of convergence, it appeared to be situated between γ and ζ Leonis, very nearly three times nearer ζ than γ.

At the Botanical Gardens, which are situated on an elevated plain behind the town, Professor Shübeler observed a large fireball to descend, apparently, on a small island in the fjord about two English miles distant, and on striking the ground, to throw up a large number of sparks or glowing fragments in all directions.

A gentleman who, with some friends, saw the fall some miles out in the country, has told me that they had the impression of hearing a faint hissing noise during the passage of two or three large fireballs.

At 1^h 42^m a flash of lightning was observed. This was not perceived by my two friends and myself, though we were then in the garden, but by two ladies and my son, standing at a window in my house; and at 2^h 20^m, 2^h 32^m, and 3^h 7^m similar flashes were seen.

On account of the incessant flaring of a light which we had on a table in the garden, by the side of a chronometer, it would not be unlikely that we might have failed to observe a faint flash of lightning; and when the last three occurred, my friends and I had gone into the house. It might, however, be possible that the flashes were caused by fireballs, although all the three who saw them state most positively that the flashes had all the peculiar appearance of lightning; and it may be right to observe that none of them had any knowledge of the fact of lightning not unfrequently attending meteoric showers.

I have since seen in the papers that in London and, I believe, at Glasgow lightning has likewise been observed; and this, as well as the violent magnetic disturbance observed at Ancona, seems to corroborate the fact that the flashes were caused by lightning and not by meteors.

The following evening (14th of November) I saw a fireball at about 8 o'clock, of the same appearance as that most common the previous night; but there have been observed seven or eight in all by others this evening, as far as I have been able to ascertain.

From what has been said above, the time of maximum density occurred between 2^h and 2^h 15^m, or about 2^h 7^m(=1^h 24^m Greenwich mean time). At Upsala it occurred between 2^h 15^m and 2^h 30^m, or about 2^h 22^m Upsala time(=1^h 11^m Greenwich time). Six observers counted there during the fifteen minutes (2^h 15^m–2^h 30^m) 1600 meteors (=17·7 per minute for each observer).

In London I find the maximum occurred at 1^h 10^m, at Oxford at 1^h 24^m (probably Oxford time) =1^h 29^m Greenwich time, and at Glasgow it occurred at 1^h 10^m–1^h 20^m =about 1^h 15^m (probably Glasgow time) =1^h 32^m Greenwich time. It seems, therefore, that while the maximum at Upsala and London occurred at the same time within about one to two minutes, it occurred at Christiania later than at these places, but earlier than at Oxford and Glasgow.

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THE METEOROLOGICAL SOCIETY,
Session 1866–67,
25 GREAT GEORGE STREET, WESTMINSTER, S.W., at 7 P.M.

1866.	November	21	1867.	March	[illegible]
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OF

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EDITED BY
JAMES GLAISHER, Esq., F.R.S., SECRETARY.

1867, APRIL 17.

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Vol. III. 1867, APRIL 17. [No. 31.

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Rev. Philip H. Newnham, M.A., Gervis Villa, Bournemouth;
Lieut. G. L. Tupman, R.A., Eastney Barracks, Portsmouth;

were balloted for and duly elected Fellows of the Society.

CXLI. *On the recently conjectured Identity of the April Meteors with Comet I.* 1861. By W. T. Lynn, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich.

It is now some time since the attention of observers has been called to the fact that the second comet of 1862, discovered by Tuttle, of Cambridge, Massachusetts, on July 18, has an orbit very closely agreeing with that which has been found for the August meteors. Signor G. V. Schiaparelli, of Milan, who first noticed this extraordinary coincidence, infers from it that the comet is nothing more than a very large meteor of the August system. Later, Herr C. F. W. Peters, of Altona, remarked that the orbit obtained by Mons. Le Verrier for the November meteors corresponded very nearly with that of Tempel's Comet of 1866. Schiaparelli also deduced the same conclusion by means of an orbit of the November meteors which he had calculated himself, making use of the latest English observations. And this has quite recently obtained the fullest and most satisfactory confirmation from an elaborate investigation by Professor Adams, which was communicated to the meeting of the Royal Astronomical Society held last March. A similar inference has of course been suggested as in the previous case—that the comet was in fact an assemblage of very small cosmical bodies, which at a distance presented the appearance of a whole.

I ask leave now to bring to the attention of the Society some very recent investigations regarding another meteoric shower which may be looked for on the 20th of the present month of April. By the independent calculations of Dr. Weiss, of Vienna, and Dr. Galle, of Breslau, recently communicated to the Astronomische Nachrichten, it seems not unlikely that this may be identified with Comet I. 1861 (first discovered by Mr. Thatcher, of New York, on April 4), supposed to have a period of about 415 years.

Dr. Weiss says that the previous investigations led him to the idea that comets, from the cloudy nature of their state of aggregation, are unable, at their approach to the sun, partly on account of the change of the conditions of stability of such systems of material points, and partly on account of the physical movements which they suffer, to continue as a whole, but must repel particles, which afterwards cohere about new centres of attraction, and move round the sun in orbits possessing a great similarity to that of the comet. Now, in the case of periodic comets, these products of dispersion will gradually accumulate along the whole extent of the orbit; and if this intersects, or even nearly approaches, the earth's, we shall, at our annual passage through that point, witness a shower of shooting-stars. According to this, every periodic comet must cause the formation of a ring of meteors; and Dr. Weiss therefore undertook the labour of calculating the radii vectores of all the known periodic comets at their ascending and descending nodes. He thereby ascertained, amongst other facts, that when Comet I. 1861 was in its descending node the difference of the radii vectores of the earth and comet was only 0·002, and that the earth passes through that point on the 20th of the month of April*.

---

* Ast. Nach. No. 1632.

Dr. Galle states that he, too, was led to publish* an investigation of this kind at once, because of the near approach of the April shower, which it was desirable to have more completely observed than hitherto. He was induced to make this investigation from remarking that the line of nodes of the comet corresponded to 30° of the sun's longitude—that is, to the 20th of April, a day on which showers of shooting-stars have repeatedly been observed, and for which the different observers agree in placing the radiant-point in the neighbourhood of the constellation Lyra. He first computed from the elements of the comet the radiant-point of the cometary particles, and found for its apparent place, referred to the ecliptic at the time of passage through the descending-node,

Longitude =267°·2, latitude = +57°·0.

Comparing this with the radiant-point of the April meteors given by Mr. Alexander Herschel†, namely, R.A. 277°·5, N.P.D. 55°·4, or

Longitude =281°·6, latitude = +57°·0,

the agreement is sufficiently remarkable. In the collection of determinations of the radiant-point of these meteors given by A. Herschel and P. Greg‡, a margin must evidently be allowed for the uncertainty of our knowledge of it, making it desirable to have it better known.

Dr. Galle, however, has also calculated from the latter an orbit for the meteors, assuming Oppolzer's period and major axis of the comet, and found the following elements, which are placed side by side with those of the comet:—

	Meteors of the 20th of April.	Comet I. 1861.
log a	1·746	1·746
log q	9·980	9·964
e	0·9829	0·9835
π	236°	243°
☊	30°	30°
i	89°	80°
	Motion *direct*.	Motion *direct*.

Any essential improvement of the meteoric orbit by assuming a different period would scarcely, he says, be possible at present, since it is difficult to make out such a one from the data known. These are given by J. Newton, of New-Haven, as

---

* Ast. Nach. No. 1635.

† Report of the British Association for 1864, p. 99.

‡ Proceedings of the British Meteorological Society, Jan. 1865.

B.C. 687, 15;

A.D. 582, 590, 741, 1093, 1094, 1095, 1096, 1122, 1123, 1803.

"But if," adds Dr. Galle, "the period is, as appears probable, long, an orbit only slightly different would be obtained, even on the supposition of parabolic velocity; so that at present the hypothesis of the comet's period for that of the meteors seems to be the simplest.

"Finally, if other correspondences between radiant-points of meteors and comets coming near the earth's orbit should hereafter be detected, the difference between direct and retrograde comets would be a rather material one, as it is evident that a meteor moving in the same direction as the earth, and consequently with much smaller relative velocity, will be exposed to deflexion from its path by the earth's attraction to a much greater extent than one moving in the opposite direction."

CXLII. *Meteorological Notes on Jersey.*

By Lieut.-Col. Austen, F.M.S.

The public has been long since made familiar with the meteorological features of the island of Guernsey, through the copious statistics furnished to the Meteorological Society by Dr. Hoskins, F.M.S.; but the climatology of Jersey is, comparatively speaking, but little known generally, being classed by most persons as identical with that of its sister island; whereas, on a closer analysis of its climatic peculiarities, it will be found to differ therefrom in many essentials; and if any physicist of experience will take up a map of the Channel Islands, constructed on a scale to comprehend the whole of the circumjacent areas, continental and oceanic, he will at once recognize the causes of such meteorological differences. By a residence here for more than a year and a half now, including the two occurrences of the most material season of observation (namely, the *winter*), coupled with a study of all the local statistics I could collect bearing on its climatology, I think I am qualified to form a pretty fair estimate of the Jersey climate, and to pronounce it every way preferable to either that of Devon or Somerset—in both of which counties I have resided, and in each division thereof too. The quantity of rain that falls in Jersey must not be deemed a criterion of its dampness, however (and even this is less than that of Devon, Cornwall, and Somerset); for the nature of its absorbent soil, and its very undulatory surface, tend greatly to mitigate this, coupled with the almost constant prevalence of wind causing a powerful evaporation throughout the island, whilst a solar heat of great actinic power tends also very materially thereto in spring, summer, and autumn; and from every side the saline and ozonic elements commingle their respective contributions, night and day, from the ocean that surrounds this *île des fruits*, as it is happily called. Even the treacherous *Eurus* loses much of its bitter character, in Jersey, from this, its insular position; and the cool nights of summer, no less than the mild nights of winter receive their genial type from its insular position, open to the westerly winds; whilst its *equable* day and night temperature owes its origin to the same highly favoured position of the island, sheltered as it is by France, on the one hand, and open to the Gulf-stream influence and the Atlantic breezes on the other. The following Tables (pp. 394, 395) will evidence the meteorological features of Jersey.

Ozone prevails, moreover, to a very great extent in Jersey, thus adding greatly to its sanitary condition; and what has struck me often as very remarkable is the fact that during the heavy gales of the autumn and winters of the two past years, when the numerals 12 and 10 have designated their force in the United Kingdom, according to the Board of Trade Reports (as published in the daily papers), the same gales *here* have only been of 8 and 6 force respectively, though so much nearer the oceanic area whence they have blown, viz. the S.W. and S.E. points of the compass. A cold dense fog is also a rare meteor in Jersey, though sea-mists and haze are prevalent at times, in the early spring and late autumn mornings,—at St. Helier mainly, however, where the high ground and smoke tend to aggravate the former greatly, as the heights above confine the mist and smoke coming from the bay, which the cold of the plateau above the town condenses, and also at times precipitates.

In treating of the meteorology of Jersey, the anemology of the island merits especial notice; and having in all parts of the world devoted attention to *winds* in general, so those of Jersey, during my sojourn here, have engaged much of my attention — the more so, indeed, as I have for many years resided by the seaside, in Wales and the west and south of England, and have made the winds of the seaboard my peculiar *study*. Now the main wind-

The Meteorological Record of St. Helier, Jersey, N. lat. 49° 8′, for the years 1865 and 1866.

1865.	A.	B.	C.	D.	E.	F.	G.	H.
	°	°	°	°	°	°	in.	
January	53·0	38·0	25·4	51·9	36·9	10·2	6·99	0·61
February ...	52·5	33·0	23·0	52·2	41·8	8·8	3·31	0·86
March.........	52·8	40·0	29·9	52·1	38·4	10·2	3·34	0·66
April	78·2	53·3	37·0	75·1	51·1	17·0	2·04	0·76
May	74·2	55·8	36·1	72·5	50·3	15·4	2·88	0·77
June	81·8	61·3	44·0	79·5	54·1	17·8	1·51	0·71
July	76·5	64·5	48·0	76·9	57·3	14·7	2·19	0·77
August	79·0	65·1	46·3	76·2	58·5	13·2	1·95	0·77
September ...	82·4	67·1	49·8	80·7	57·4	16·9	0·93	0·64
October	76·4	55·0	34·0	74·7	56·1	14·2	7·47	0·89
November ...	60·1	49·3	34·0	58·8	49·3	10·7	3·48	0·69
December ...	54·1	38·7	33·8	52·3	43·7	8·3	2·92	0·61
Sums total ...	821·0	621·1	441·3	802·9	594·9	157·4	39·01	8·74

1866.	A.	B.	C.	D.	E.	F.	G.	H.
	°	°	°	°	°	°	in.	
January	54·6	43·3	31·8	54·4	46·5	9·1	4·11	0·90
February ...	54·8	42·8	31·0	55·7	46·3	9·0	3·30	0·86
March.........	57·6	41·4	30·0	55·7	44·5	9·7	2·67	0·80
April	74·8	49·2	31·8	71·2	51·7	14·1	1·72	0·33
May	72·8	47·6	36·0	70·0	45·8	15·5	1·21	0·68
June	81·7	56·2	46·0	79·6	59·6	15·9	2·05	0·79
July	86·0	63·0	44·5	80·8	60·1	14·4	1·77	0·75
August	77·3	63·8	46·0	76·1	55·7	12·5	3·68	0·94
September ...	70·0	59·0	42·0	68·4	54·9	10·9	7·76	0·84
October	69·0	55·8	41·0	65·5	56·7	11·0	0·82	0·83
November ...	61·4	43·5	33·0	60·1	53·1	10·8	2·49	0·84
December ...	58·6	38·4	32·0	57·2	50·5	8·6	3·51	0·92
Sums total ...	818·6	604·0	445·1	794·7	625·4	141·5	35·09	9·48
Add sums total of 1865 ...	821·0	621·1	441·3	802·9	594·9	157·4	39·01	8·74
Grand total of two years' record......	1639·6	1225·1	886·4	1597·6	1220·3	298·9	74·10	18·22

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A. Hottest day in each month.
B. Coldest day in each month.
C. Coldest night in each month.
D. Mean temperature of the four hottest days in each month.
E. Mean temperature of the four corresponding nights.
F. Mean range of the month's day and night temperature.
G. Total of rainfall in the month.
H. Relative mean humidity of the whole month.

The Jersey Record is kept by a Captain of the R.N. and the Hydrographer locally of the Admiralty.

The Jersey Seasons' Temperature of 1831–35 compared with the same for the last two years.

Seasons.	Months.	Dr. Hooper's (St. Helier) five years' monthly averages from 1831–35.	Five years' mean of each season.	Mean of seasons of 1865–67.
		°	°	°
Spring.	March	47·7	51·2	51·9
	April	50·1		
	May	57·8		
Summer.	June	61·2	62·8	63·7
	July	63·6		
	August	63·7		
Autumn.	September	58·8	54·3	57·9
	October	55·6		
	November	48·4		
Winter.	December	45·2	43·8	45·1
	January	41·6		
	February	44·7		

The Mean Annual Temperature of the places mentioned.	°
Nelson, New Zealand	54
North Island, New Zealand	59
Sydney, New South Wales	66
Cape Town	67
Port Arthur, Tasmania	58
Mauritius	77
Fremantle, West Australia	62
Colombo, Ceylon	80
Barbadoes	80
Madeira	64
Gibraltar	64
New York	53
Rome	60
Quebec	41
Paris	51
London	50
Halifax, Nova Scotia	44
Milan, North Italy	55

	°
Yearly average per Dr. Hooper's five years' monthly means	53·3
Do. per 'British Press' for two years' means	54·7

N.B. Rain fell on 115 days in 1865, and on 106 days in 1866, at St. Helier (one-tenth of an inch only counting as rain), by the pluviometer record.

feature I remark here is, that the *cyclones*, which scourge the United Kingdom and Ireland so frequently, NEVER *affect Jersey in their rotatory character*! This seeming anomaly I account for by the geographical position of the island, as regards the contiguous coast of France; for if any one will but look at a map of France, and draw a *true* S.W. bearing from the Isle of Ushant to the N.E., it will impinge on the English coast a little to the west of the Isle of Purbeck, in Dorsetshire; and it is along this, and its coparallels, that our rotatory storms move, as they progress *upwards* from the Atlantic, either up the Irish or English Channel (from S.W. to N.E.). Now, if a similar parallel be drawn from S.W. to N.E., and be made to pass over Jersey, it will be found to cut the French coast to the west of the port of L'Orient, on the Bay of Biscay; or seventy miles *within the shelter* of the peninsula of Brittany! If I am asked to prove *this* assertion by the action of the wind itself locally, I readily do so, thus:—In all cyclonic storms proceeding as above, in Europe, the *initial* wind to all places in the *right*-hand semicircle of the said cyclone (as we should be here) *must* be from a point between S.E. by E., and S.W. by S.; and in any case the wind would *keep shifting* more and more to the W.N.W., as the vortex of the cyclone progressed to the N.E. Now such is *not* the wind-action observed here, as the published Tables and my own personal observations of many months satisfactorily prove to me; for the *character* of all the heavy winds in Jersey is that of *direct* gales, blowing for 18, 24, 48, or 60 hours *consecutively*—the S.E. and S. winds especially (which is *so contrary* to their action in England); but in Jersey, no doubt, the *south* wind receives its impulse from the Bay of Biscay coast-line, it lying due north of Bayonne, and so has the full sweep of that great mass of warm ocean as its *fons et origo*.

Another peculiarity I would observe in the Jersey winds is, that they very seldom retrogade, or *back*, against the course of the sun, and blow but little from *due* north (true); indeed Dr. Hooper, who has written much on the climate of Jersey, assured me lately that he had *never* known a strong wind to *back* here, when he wrote his work thirty years ago: but I *have* traced this retrogression in a few instances of late years, certes! Finally, I may remark that, according to the wind-record *here*(where the land-scale of from 1 to 6 numerals is kept), No. 6 has been only twice noted for half a day, in January and February 1866, from south, within the last twenty-seven months, and No. 5 during eleven afternoons or forenoons,—these numerals indicating, respectively, a *violent* gale of from 80 to 100 lb. pressure on the square foot and a velocity of eighty miles an hour, or a *heavy* gale of 65 lb. pressure; and yet Jersey, by most persons, is classed as the Island of the Winds! But I hope the above statement of recorded *facts* will tend to remove this false character from so fair and highly favoured an island as this undoubtedly is.

CXLIII. *The Storm at Monte Video, 27th October*, 1866.

By Albert De Lisle, Esq.

I take the liberty of sending you a series of observations taken before and during the storm we have experienced since Saturday afternoon the 27th instant, and which on Sunday and Monday increased to a hurricane. This storm fell heavily on the port of Buenos Ayres; and the list of disasters amongst the shipping has been very heavy and with great loss of life. The following observations may be interesting. On the 25th and 26th, dense, heavy-looking clouds in long streaks and with sharp outlines were forming to the E.S.E. On the 27th, scud, and heavy clouds from N.; at mid-day heat oppressive, sun scorching, and thunder-clouds from N.; towards 4 P.M. wind shifting to E., and at 9 P.M. the storm was heavy from E.S.E., rising in strong puffs, and continuing all night; on Sunday the storm blew a hurricane at 1 P.M. and continued all Monday; on Tuesday, as observed the day previous, the higher clouds came from N., whereas there was scud flying low over the town from E.S.E.; the wind has shifted to N. with direction to the Pampero or S.W., which will end the storm.

The instruments are all placed in the shade in the open air, in a wooden shed with glass windows in front and two venetians on each side, allowing the air to circulate; the instruments are 4 feet from the ground, and about 6 to 7 inches from the wall. The situation of the house is about 90 feet above the sea-level. No corrections &c. are made in the list sent; they are simply the readings as taken down at the time. I thought these particulars might prove of interest; and for this reason I have taken the liberty of sending them to you. My business sometimes prevents my taking them at 9 A.M. and 9 P.M., which is the reason you will find some observations at different hours.

The camp-stand thermometer and Phillips's maximum I only received a few days ago.

Should these observations be of any use to you in future, I shall be happy to supply them by every mail. Any suggestions would be thankfully received.

I find great difficulty in ascertaining the correct reading of my barometer compared with those on board ship; for, on comparison of those on board several vessels obtained at the same time, they all read differently.

Oct.	Hour.	FitzRoy's Barom.	Therm. At.	Centigrade Hygrom.		Phillips's Max.	Adie's Therm.	Camps-st. Therm.	Centigrade Therm.		Glaisher's Rain-gauge.	Wind.	Direction of Wind.
				Dry.	Wet.				Max.	Min.			
		in.	°	°	°	°	°	°	°	°	in.		
20	9 P.M.	29·69	62	17	16	...	62	...	20	16			
21	9 A.M.	29·68	71	14	12·5	...	69·5	...	21	15			
	9 P.M.	29·94	56	13·5	11	...	55·5	...	21	13			
22	9 A.M.	30·18	65	16	12	...	62	...	16	11			
	9 P.M.	30·22	52	11·2	8	...	52	...	15	11			
23	9 A.M.	30·28	60	14	11	...	58	...	13	10			
	9 P.M.	30·22	56	14	12	...	56	...	15·5	13			
24	9 A.M.	30·28	67	17	15	...	64	...	17	13			
	9 P.M.	30·20	57	14	12	...	56·5	...	17	13			
25	9 A.M.	30·14	68	18	15	...	65	...	18	11·5	...	N.	
	9 P.M.	30·04	60	16	15	...	60	...	19	11	...	"	
26	9 A.M.	29·98	69	19	16	...	67	...	19	11	...	"	
	9 P.M.	29·78	66	19	16	...	65	...	24	18	...	"	
27	9 A.M.	29·76	74	23	19	74	73·5	74	23	14	...	"	N.E.
	9 P.M.	29·96	58	15	12	78	57·5	57	26	13	...	N.E.	E.
28	9 A.M.	30·03	53	12	10·5	57	53	53	13·5	11	0·21	E.S.E.	
	9 P.M.	30·04	51	11	11	54	52	52	12	10·5	1·16	"	
29	9 A.M.	29·90	56	14	13	56	56	56	14	10	0·90	"	
	9 P.M.	29·90	60	16	15	61	59·5	60	15·5	13	0·14	"	
30	8 A.M.	29·80	63	17·5	16	64	62·5	63	17	15	0·12	"	E.
	10 P.M.	29·64	64	18	17	68	64	64	19·5	16·5	0·35	N.E.	N.
31	9 A.M.	29·45	60	15	13·5	65	59·5	59	17·5	13	0·93	N.	W.

The Storm.

The city and port of Monte Video have been visited by one of the most fearful storms experienced in the present century, and which we regret to say is attended with much loss of life and property. In 1835 there was a great storm, in which no fewer than forty-three vessels were washed ashore. On August 30, 1860, we had a terrific gale, which lasted two days, causing immense destruction in the port. The present storm has not been, perhaps, so dreadful as the last mentioned, although the tide is said to have reached the same height; and until full particulars be learned from the suburbs and country districts it is difficult to estimate the amount of damage caused since last Saturday night. Unhappily we have to anticipate tremendous losses on the sheep-farms, as the shearing-season is at its height, and most of the flocks shorn last week will partially or wholly perish: in the storm of 1860 some estancieros lost as many as 4000 sheep in a single night.

The present storm was, in a manner, foretold ten days before, by a wonderful mirage visible at Colonia, the spires and turrets of Buenos Ayres appearing high in the clouds at sunset, as well as the masts of the vessels in port. After that the weather was very threatening: the heat on Saturday morning was something extraordinary; a blinding dust-storm ensued till the afternoon; the sky was shut out by dense clouds that foreboded strange weather; and at 2 P.M. the gale began; the river rose alarmingly, and the packet had to postpone her departure.

At 4 o'clock the reading of the barometer fell rapidly. A boat had put off for the packet with some ladies and gentlemen, who safely got alongside and were pulled on board with a rope tied round their waists. About sundown the beach was covered with small birds seeking shelter in the houses—another indication of the coming storm.

Before sunrise on Sunday morning it began to rain in torrents, which has lasted up to the hour we write (5 P.M. Monday evening) almost without a moment's intermission, being probably the heaviest fall of rain remembered by the present generation. At the same time the wind blew a fearful gale, sometimes in violent gusts, again with all the fury of a hurricane; and the injury to life and property is announced in sad reports coming in every moment from various quarters.

On Sunday night the streets had become rivers, and at 9 o'clock all the gas in the city was suddenly extinguished. The river had broken into the gas-house, swept down the fortified wall with its solid buttresses, and put out the fires: it was most fortunate that an explosion did not take place. A hundred yards of the inner wall facing the Retiro was thrown down, and the water swept madly over the side near the battery. The sudden darkness in the city lent new horrors to the night: people had to grope their way through the streets; and those in carriages, returning home, ran imminent risk. The theatres were luckily closed, owing to the weather; otherwise a scene of alarm and robbery would certainly have occurred.

The casualties in the port are numerous; but many vessels sought safety in time on Sunday morning by making for the

Tigre: twenty whaleboats were sunk or washed ashore, two schooners were washed up on the Boca Railway, another is among the trees near Torres's quinta, and another at Palermo.

At 5 o'clock on Monday morning the Commercial Rooms in the Calle Mayo were crowded with people. The morning was clear, and the telescopes revealed the sad story of a vessel foundered in the outer roads, nothing but the rail visible, and probably all hands perished. The French ship 'Bossue' lost her bowsprit; and a dismasted vessel was driven close to the mole. At the Capitania five corpses were brought in, three males and two females: among these were said to be the sergeant of the Gas-house Battery and his wife, an ostler belonging to one of the "caballerizas," and the captain of a Hanoverian brig and his wife. An English gentleman who had started early on a visit to the long line of beach assured us that he counted twelve corpses.

At 7 o'clock the tide, which had been rising from 8 o'clock the previous evening, began to subside. The scene on the beach baffled description: the river had knocked down some of the rails and pillars, and made a clean sweep over the Paseo Julio and Cazon's trees; the tramway bridge was washed away and the adjacent house almost submerged, while the lower parts of the streets debouching on the beach were inundated.

At 9 o'clock the weather abated somewhat. The accounts from Boca and Tigre were terrible, and lead us to fear a great loss of life. A broker who went out to Las Conchas on Sunday morning found the whole country inundated: on Milberg's property even the tops of the trees were covered. Mr. Matti, who went out to send off a steamer, saw numbers of boats and canoes rescuing the inhabitants of Tigre and the Islands, and putting them on board the large vessels, which were enabled to enter the canals, so high was the tide.

The mole suffered somewhat: the end is slightly twisted, two planks are wrenched up in the middle, and some pieces knocked out near the Casillas. All along the beach great ravages are reported. No fewer than thirty-seven whaleboats are wrecked off the end of Calle Tucuman. A family was drowned near the Gas-house: the Palermo Road is strewn with boats, spars, and *débris*, which have been washed over the railway, and some fragments cast into the quintas of Messrs. Estrada, Torres, &c. The barque 'Sylphide,' which was so long a wreck in front of Mr. Simpson's house, was smashed up into a thousand pieces on Sunday night; and the weighty machinery and wreck of the 'Oriental,' imbedded in the sand at the gas-house, were carried like a straw before the storm and deposited near the Recoleta, where they will be high and dry at low water. The fury of the storm could not be exaggerated.

The destruction about the south end of the city is greater than on any former occasion. The Boca Railway and Mr. Billinghurst's brick-yard have almost disappeared; and the turret in course of erection on San Telmo Church was blown down. Details of the awful scene at the Boca and Barracas will be found below.

Scene at the Boca.

The storm has been peculiarly severe, and the damage unexampled. In the Boca district, early on Sunday morning, the rains during the night had flooded the streets and rendered them almost impassable; and much apprehension was entertained that as the wind was north-east, and the Riachuelo high, up to its banks, a flood would ensue; but up to 7 o'clock on Sunday night no damage of any kind had occurred. At 8 o'clock, however, the alarming news spread through the dense population of the Boca that the river was rising, and immense efforts were made at once to leave; but although it was possible to wade through the surrounding "potreros," it was such an unpleasant affair, that, with the exception of a few migratory Italians, people remained in their houses. The river kept rapidly rising, and at midnight the waves of the River Plate made a clean breach over the mole and inundated the town. As most of the houses in the Boca are built on stakes, and with an upper story, although in the streets there was at least 10 feet of water, the families were secure aloft, and the whole population remained on guard during the night, not a soul having the courage to go to bed. Shortly before 5 o'clock the waters began to subside somewhat, owing to the wind having calmed down a little.

All the fields or 'potreros' extending from the Boca to Barracas were covered, and the mad waves, as they dashed through the Miguens quintas, tossed the spray high over the cypress- and paradise-trees into the Calle Larga. On Monday morning the scene of watery desolation that met the eye baffles all description. During the night it was rumoured that several poor families living in mud ranchos in the potreros had perished; and as the waters were now so high that even the tallest horse could not find footing along the road, universal efforts were made to get together launches, canoes, boats, &c. Immense floats were kept plying all day yesterday from the Yellow House to the Boca, taking off the affrighted women and children.

CXLIV. *On Temperature at different Heights.*

By John Bloxam, Esq., F.M.S.

In the last Number of the 'Proceedings' there are some papers referring to the variations of temperature observed in different strata of the atmosphere. Believing this to be an interesting subject and one not as yet well understood, I will communicate to you a few facts that have come under my own observation, though I am not sure that they are enough to the point to be worth your notice. I have two sets of observations—one giving relative values for two stations, viz.:—Newport, placed in a valley only 20 feet above the sea; and a spot less than a mile distant from Newport, nearly on the summit of the hill, and elevated 180 feet above the Newport station. In the following Table I give a comparative view of the monthly means for the minimum, the maximum, the 8¼ A.M., and the 9 A.M. temperatures, as observed simultaneously at these two stations. The Table indicates the excesses and defects at the upper station as compared with the lower, under the heads specified. The observations were made daily throughout the year 1856. The thermometer-stands were made alike, and the readings of the thermometers were reduced to one standard.

	Min.	Max.	8¼ A.M.	9 A.M.
January	−0°·7	−0°·6	−0°·5	−0°·8
February ...	−0·2	−0·6	−0·5	−0·7
March.........	0·0	0·0	−1·5	−1·6
April	+1·0	−0·2	−2·0	−1·6
May	−0·2	−0·3	−2·1	−1·6
June	+0·7	−2·1	−3·9	−3·6
July	+0·6	−0·7	−2·9	−2·7
August	+0·8	−0·7	−2·6	−2·0
September ...	+2·1	−1·1	−2·2	−2·6
October	+0·9	+0·1	−0·3	−0·8
November ...	+1·1	−0·6	−0·2	−0·5
December ...	−0·1	−0·5	−0·4	−0·3
Means.........	+0·50	−0·61	−1·59	−1·57

I separate the twelve months into two categories (viz. one of winter months, and one of summer months—the former including October to March, the latter April to September), and obtain the following results:—

	Min.	Diff.	8¼ A.M.	Diff.	9 A.M.	Diff.	Max.
Winter ...	+0°·17	0·74	−0°·57	0·21	−0°·78	0·41 Rev.	−0°·37
Summer..	+0·83	3·44	−2·61	0·26 Rev.	−2·35	1·50 Rev.	−0·85

In the winter, the diurnal temperature does not fall to quite so low a point at the upper station as it does at the lower station, taking the average of the six months; but December, January, and February give a lower minimum to the upper station. The temperature rises more slowly in the early part of the day at the upper station; or, at any rate, the increment is not so great between minimum and 8¼ A.M. at the upper station, the difference in this respect being 0°·74; and then again between 8¼ A.M. and 9 A.M. the difference in increment is 0°·21; so that here there is clearly a less rapid rise. The temperature does not rise so high at the upper station as at the lower; but it makes a greater rise, if not a more rapid one, between 9 A.M. and the hour of maximum. In summer, the minimum temperature is considerably higher at the upper station, and the rise between minimum and 8¼ A.M. is very small at the upper station, compared with what it is at the lower. But between 8¼ A.M. and 9 A.M. the temperature rises somewhat more quickly at the upper station. The maximum temperature is nearly a degree lower at the upper station; but the increment is much greater between 9 A.M. and the maximum at the upper than at the lower station. The more rapid increment of temperature in the valley at about 8 or 9 o'clock in the morning, though it is *less* rapid at a later hour, is the most prominent fact. This inequality is much greater in the summer than in the winter; and in the summer this unequal movement ceases before 9 o'clock. The explanation is, perhaps:—When the sun's rays first reach the valley the additional heat is there retained and is soon manifested at 4 feet above the ground, though on the hill-top it is lost in the surrounding atmosphere. Later in the day the warm air of the valley probably ascends the hill, though this movement is not sufficient, generally, to raise the heat on the hill to the valley-temperature.

In October so many as eighteen days gave the higher maximum to the upper station, and in March sixteen did so. December gave only two days of such excess, and June four. This is perhaps accounted for in the spring by the atmosphere warming more quickly than the earth*; *i. e.* the whole body of the atmosphere. In the autumn, when the earth retains its heat more than the atmosphere does, the excess may possibly have been caused by the greater evaporation in the valley: the hill has, in fact, a dry surface, the soil having a large proportion of gravel in it; the excess was greater in a breeze than with a calm atmosphere, in the proportion of 1°·3 to 0°·6; the wind, too, was N.E. or S.E. on fourteen days out of the eighteen. The N.E. wind gave on the average an excess of 1°·2, whilst the S.W. gave 0°·8. As regards minimum temperature, the cooling of the earth by radiation, and, consequently, of the atmosphere 4 feet from the ground, is great in the valley; but on the hill the thermometer is more under the control of the mass of atmosphere, and is but little affected by the temperature of the earth. In short, the atmosphere takes heat from the earth in the valley much more than it does on the hill. The higher minimum that some of the winter months give at the lower station may be attributable to the smoky and foggy state of the air in the town. In all the months there are a considerable number of days that give the higher minimum to the lower station; and the seven months, in the Table, that give the higher minimum to the upper station have nearly as many — marks as + marks. There were only two days in the six summer months that gave the higher temperature to the upper station at 8¼ A.M., and there were only three that did so at 9 A.M.; and there was a cloudy sky at the time of each of these occurrences. In the winter months, excess at the upper station at these two hours was more frequent; and this occurred both with cloud and with sunshine, but twice and thrice as often with cloud or fog as with sun. These two stations being on the ground, the observed temperatures may in each case have been in a great measure the result of local conditions, and the differences may not, altogether, have been dependent upon inequality of height.

The other set of observations are supposed to be independent of local peculiarities; but the results, still, do not afford clear evidence of the effects of simple elevation. The observations were made on the relative temperature of the atmosphere 4 feet from the ground at a low level, and of that of the rain as it fell. The arrangements made were not very satisfactory as a means for determining the difference between the atmospheric and the pluvial temperatures; but they were sufficient, perhaps, for showing the contrast between the season of increasing temperature and the season of decreasing temperature. During the period April 3 to July 7 the rain showed the higher temperature by 0°·78; and during the period September 28 to December 12 the rain had the lower temperature by 0°·61, taking the mean result for each period. During the other portions of the year the results were less distinct.

---

* The temperature at the bottom of a deep well in Newport was found to be at its minimum in March and April, the maximum having occurred in December—the whole range for the year not being more than 0°·3.

CXLV. *On a Hailstorm at Leamington upon Sunday, April 14th, 1867.* By S. URWICK JONES, F.M.S.

AT 9 A.M., the usual time of observing, the reading of the barometer, reduced to 32° and sea-level, was 29·465 in., the dry-bulb thermometer showed the temperature to be 51°, the wet-bulb reading 48°·2, wind blowing a gale from the south-west, the sky overcast, accompanied by rain, which continued to fall almost without intermission until 2 P.M.; the wind had then veered to the west and was less violent, the rain falling only at intervals; this continued until about 7 P.M., when the wind had gone to the north-west; the sky was then covered by dark leaden-looking clouds, giving evident warning of an approaching storm. At $7^h\ 5^m$ distant rumbling thunder was heard; this was speedily followed by a brilliant flash of lightning from the north-west and a heavy peal of thunder, and at $7^h\ 10^m$ large hailstones began to fall thickly, accompanied by heavy gusts of wind; in a few minutes the ground was white with hail, the rattling noise of which, and the appearance of the atmosphere, conveyed to the mind a sensation of anxiety and alarm: the reading of the barometer at 32° and sea level was 29·229 in.; the temperature had fallen to 40° (the maximum of the day having been 56°·3), the wet-bulb reading 39°. Upon examination of the hail, I found it to be an inch and a half deep; the pieces were opake and measured three-eighths of an inch in diameter, four of them weighing 30 grains; in some situations, where the hail had drifted by the force of the wind, it was 10 and 12 inches in depth. The damage to conservatories and fruit-trees has been very great, the blossoms of the currant- and gooseberry-trees being cut off as though stripped by the fingers; and in some of the places of worship it was found necessary to suspend the service until the storm had ceased. No one here remembers a hailstorm of such extreme violence.

CXLVI. *The Astronomer Royal on the Deter-*

Corresponding Numbers of Elevation in English Feet, and of Inches (the Mean of Atmospheric

Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.
ft.	in.	ft.	in.	ft.	in.
0	31·000	2000	28·807	4000	26·769
50	30·943	2050	28·754	4050	26·720
100	30·886	2100	28·701	4100	26·671
150	30·830	2150	28·649	4150	26·622
200	30·773	2200	28·596	4200	26·573
250	30·717	2250	28·544	4250	26·524
300	30·661	2300	28·491	4300	26·476
350	30·604	2350	28·439	4350	26·427
400	30·548	2400	28·387	4400	26·379
450	30·492	2450	28·335	4450	26·330
500	30·436	2500	28·283	4500	26·282
550	30·381	2550	28·231	4550	26·234
600	30·325	2600	28·180	4600	26·186
650	30·269	2650	28·128	4650	26·138
700	30·214	2700	28·076	4700	26·090
750	30·159	2750	28·025	4750	26·042
800	30·103	2800	27·973	4800	25·994
850	30·048	2850	27·922	4850	25·947
900	29·993	2900	27·871	4900	25·899
950	29·938	2950	27·820	4950	25·852
1000	29·883	3000	27·769	5000	25·804
1050	29·828	3050	27·718	5050	25·757
1100	29·774	3100	27·667	5100	25·710
1150	29·719	3150	27·616	5150	25·663
1200	29·665	3200	27·566	5200	25·616
1250	29·610	3250	27·515	5250	25·569
1300	29·556	3300	27·465	5300	25·522
1350	29·502	3350	27·415	5350	25·475
1400	29·448	3400	27·364	5400	25·428
1450	29·394	3450	27·314	5450	25·382
1500	29·340	3500	27·204	5500	25·335
1550	29·286	3550	27·214	5550	25·289
1600	29·233	3600	27·164	5600	25·242
1650	29·179	3650	27·115	5650	25·196
1700	29·126	3700	27·065	5700	25·150
1750	29·072	3750	27·015	5750	25·104
1800	29·019	3800	26·966	5800	25·058
1850	28·966	3850	26·916	5850	25·012
1900	28·913	3900	26·867	5900	24·966
1950	28·860	3950	26·818	5950	24·920
2000	28·807	4000	26·769	6000	24·875

mination of Heights from Barometer Readings.

Readings of Aneroid or Corrected Barometer in English Temperatures being 50° Fahrenheit).

Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.
ft.	in.	ft.	in.	ft.	in.
6000	24·875	8000	23·115	10000	21·479
6050	24·829	8050	23·072	10050	21·440
6100	24·784	8100	23·030	10100	21·401
6150	24·738	8150	22·988	10150	21·361
6200	24·693	8200	22·946	10200	21·322
6250	24·648	8250	22·904	10250	21·283
6300	24·602	8300	22·862	10300	21·244
6350	24·557	8350	22·820	10350	21·205
6400	24·512	8400	22·778	10400	21·166
6450	24·467	8450	22·736	10450	21·128
6500	24·423	8500	22·695	10500	21·089
6550	24·378	8550	22·653	10550	21·050
6600	24·333	8600	22·611	10600	21·012
6650	24·288	8650	22·570	10650	20·973
6700	24·244	8700	22·529	10700	20·935
6750	24·200	8750	22·487	10750	20·896
6800	24·155	8800	22·446	10800	20·858
6850	24·111	8850	22·405	10850	20·820
6900	24·067	8900	22·364	10900	20·782
6950	24·023	8950	22·323	10950	20·744
7000	23·979	9000	22·282	11000	20·706
7050	23·935	9050	22·241	11050	20·668
7100	23·891	9100	22·200	11100	20·630
7150	23·847	9150	22·160	11150	20·592
7200	23·803	9200	22·119	11200	20·554
7250	23·760	9250	22·079	11250	20·517
7300	23·716	9300	22·038	11300	20·479
7350	23·673	9350	21·998	11350	20·441
7400	23·629	9400	21·957	11400	20·404
7450	23·586	9450	21·917	11450	20·367
7500	23·543	9500	21·877	11500	20·329
7550	23·500	9550	21·837	11550	20·292
7600	23·457	9600	21·797	11600	20·255
7650	23·414	9650	21·757	11650	20·218
7700	23·371	9700	21·717	11700	20·181
7750	23·328	9750	21·677	11750	20·144
7800	23·285	9800	21·638	11800	20·107
7850	23·242	9850	21·598	11850	20·070
7900	23·200	9900	21·558	11900	20·033
7950	23·157	9950	21·519	11950	19·996
8000	23·115	10000	21·479	12000	19·959

This Table is intended more particularly for the graduation of Aneroids with a circle of measures in feet concentric with the ordinary circle of barometric height measured in inches. The circle of feet is to be read off, at the upper and lower stations, by the index; and the rule for measuring the height will be:—Subtract the reading at the lower station from the reading at the upper station; the difference is the height in feet.

The Table supposes the mean temperature of the atmosphere to be 50° Fahrenheit or 10° Centigrade. For other temperatures the following correction must be applied: Add together the temperatures at the upper and lower station. If this sum, in degrees of Fahrenheit, is greater than 100°, *increase* the height by $\frac{1}{1000}$ part for every degree of the excess above 100°; if the sum is less than 100°, *diminish* the height by $\frac{1}{1000}$ part for every degree of the defect from 100°. Or, if the sum in Centigrade degrees is greater than 20°, *increase* the height by $\frac{1}{550}$ part for every degree of the excess above 20°; if the sum is less than 20°, *diminish* the height by $\frac{1}{550}$ part for every degree of the defect from 20°.

TO THE EDITOR.

Evaporation from Rain-Gauges.

SIR,—As the early history of investigations is sometimes of more importance than is at the time supposed, and as it is not infrequent for persons to be credited with opinions they never entertained, I think it always desirable that the facts should be clearly stated in publications which are likely to be of permanent reference. I therefore ask permission to transfer to your pages the following letters which appeared in the 'Times' in the spring of 1866, and subsequently to offer a few words of comment.

I am, &c.,
G. J. SYMONS.

LETTER I. RAINFALL.

To the Editor of 'The Times.'

SIR,—A great number of gentlemen in all parts of the United

Kingdom are engaged in registering the amount of the annual rainfall, to whom the information contained in this communication would be interesting. It has been noticed that the rainfall as measured by the gauge used at the Ordnance Survey-Office, Southampton, since 1854, is greater than it is found to be by observers in the immediate neighbourhood. For instance, the average rainfall, as given by Mr. Symons, for 1865, at the following five stations, Cadland, Fareham, Eling, Shirley, and Leigh Park, was 36·794 in.; but at Southampton it was observed to be 42·709 in. The construction of the gauges used at the abovenamed places is not known; but if they are of the ordinary cubical form, with a moveable funnel-shaped partition, allowing the entire inside of the vessel to be wetted by the rain, the experiments lately made, and which are still being carried on at the Ordnance Survey Office, show that a large proportion of the rainfall is evaporated in gauges of that construction from the large internal area of the vessel; and this, of course, escapes measurement. A gauge of this class, for instance, placed beside the standard gauge gave for 1865, 33·461 in., whereas the standard gave 42·709 in. The difference of 9·248 in., or about 24 per cent. of the whole, escaped measurement in consequence of the evaporation. This has been satisfactorily proved by soldering the funnel-shaped partition to the inside of the gauge, and thus causing all the rainfall to converge to the centre, below which it is caught in a small glass vessel. The common gauge thus fitted is found to give as near as possible the same quantity as the Ordnance standard.

The standard gauge is a circular funnel-shaped one of 5½ in. in diameter, from which the water is received into a bottle, and the amount ascertained by weighing; while the cubical gauge is 10 inches square.

(Signed) HENRY JAMES,
Colonel, Royal Engineers.

Ordnance Survey Office, Southampton,
March 15th.

LETTER II. RAIN-GAUGES.

To the Editor of 'The Times.'

SIR,—The letter of Colonel Sir Henry James, in your impression of Monday, has directed attention to the defective construction of gauges at present in use. A very simple contrivance would obviate an important evil—namely, the loss by evaporation, of which your correspondent complains. The gauge which I employ (a 5-inch diameter) has a slender tube 9 inches long, the bore of which is one-fourth of an inch diameter, and it dips to within half an inch of the bottom of a glass receiver. Now, instead of the open necks of these receptacles, which can never be hermetically closed by the bevelled shoulders and caps of the funnels, if the neck of the bottle itself were carefully made with a moveable ground-glass stopper containing an aperture of about ⅜ of an inch diameter for the reception of the rod of the funnel, evaporation to any extent would be rendered almost impossible. Even a well-adjusted piece of cork or gutta-percha would answer the purpose, and might be adapted to the existing funnels; it should be fitted to pass over the neck of the receiver, which would enable it to be removed without difficulty from the funnel. In summer, if the measure be not taken daily, the loss by evaporation from the common receivers is very considerable.

I am, Sir, your obedient Servant,
(Signed) R. H. ALLNATT.

Frant, March 21.

LETTER III. RAIN-GAUGES.

To the Editor of 'The Times.'

SIR,—My name having been quoted by Colonel Sir Henry James in his recent letter to you, the observers concerned not having yet replied to it, and the Ordnance Office results being, so far as I am aware, unparalleled, I trust you will allow me a few words on the subject, the importance of which I fully recognize and have had constantly before me for some years. It is rather a singular coincidence, that during the last month I have been preparing some gauges to test this very question of evaporation. Most of these gauges were exhibited at the Meeting of the Meteorological Society last night, and are now placed in my garden. I may be allowed to add that I shall be happy to show them to any observer, and to accept suggestions for further experiments. I turn now to Colonel James's letter stating that a 10-inch square gauge lost 24 per cent. by evaporation as compared with a 5½-inch bottle gauge. In 1863, Colonel Ward, of Calne, commenced a series of experiments on rain-gauges of different sizes and forms (he has more than twenty), among others, a 10-inch square, and bottle gauges of various diameters. The following are the results of two years' daily observations:—

Size of gauge.	Calne. Total two years.	Southampton. Total one year.
1-inch diameter	46·49	—
2 " "	47·96	—
4 " "	49·72	—
5 " "	49·72	—
5½ " "	—	42·71
6 " "	50·81	—
8 " "	51·17	—
12 " "	49·81	—
24 " "	49·58	—
10-inch square	49·51	33·46

Hence it will be seen that the deficiency at Calne is only three-quarters of an inch, and at Southampton more than 9 inches—say, 12 times as great.

Possibly the explanation is in the Southampton gauge not being regularly emptied. Colonel James did not say how often that was done.

The 10-inch gauge of the old Royal-Engineer pattern can, I think, hardly be called an ordinary one, seeing that, so far as I am aware, not one gauge in fifty is made of that pattern, which I agree with Colonel James was bad, but I cannot think so bad as to lose a quarter of all the rain it caught. As to the evaporation from Mr. Allnatt's gauge being of any serious moment, I wait for its amount with interest, knowing that a similar one here, emptied only once a month, did not lose 0·10 in any month last year as checked against another gauge close beside it, and which was emptied twice daily.

I hope that the matter (which is very simple) will be fully tested by several parties, each of whom must carefully test their instruments before commencing. For my own part I had begun mine: any reasonable additional suggestion shall be tried and the result communicated to you.

I am, Sir, your obedient Servant,
(Signed) G. J. Symons.

136 Camden Road, March 22.

LETTER IV. RAIN-GAUGES.

To the Editor of 'The Times.'

SIR,—Evaporation from my gauge is almost *nil*; but, I think, without due precautions, that it might amount to something considerable. I am glad to find, however, that according to the testimony of so experienced and indefatigable an observer as Mr. Symons, instruments of the construction I described are generally efficient. Nevertheless, to make assurance doubly sure, I would have them at all points as air-tight as possible.

The funnel with the rounded shoulder might be made to rest in a grooved socket, or, better still, to screw into the neck of the receiver. Evaporation from that point would thus be effectually cut off.

I am, Sir, your obedient Servant,
(Signed) R. H. ALLNATT.

Frant, March 26.

Commenting on these in the order of their publication, I would submit the following remarks:—

Letter I.—The returns for the five stations quoted by Sir Henry James for 1865, seem to suggest that the solution of his difficulty lay, not in quantity lost from the 10-inch gauge, but in undue quantity collected by his 5½-inch one in the year 1865 and in previous years. The following are the details:—

Mean of five stations	1865=36·794
5½-inch gauge at Ordnance Office	1865=42·709
Excess	5·915 inches.
Mean of five stations	1866=36·924
5½-inch gauge at Ordnance Office	1866=38·036
Excess	1·112 inch.

Thus we see that the excess of the 5½-inch gauge, which was the main basis for condemning the 10-inch gauge, almost vanishes (decreases 81 per cent.) in 1866. I sincerely hope Colonel James will communicate to your readers the results of subsequent experience, and specially whether the explanation suggested above is or is not correct.

Letters II. and IV.—These aim at an arrangement which, if attained, would be fatal to trustworthy observations. If the gauge is air-tight, or even if the only egress for air is the tube, the water will not enter the receiver, but remain outside in the funnel.

Lastly, I would ask permission to offer a few comments on Mr. G. Harvey Simmonds's article in 'Proceedings,' vol. iii. p. 326 *et seq.* In the first place it may be well to remember that though the experiments therein described were made with a Glaisher gauge, two of the conditions calculated to prevent evaporation were intentionally reversed. (1) "The gauge was freely exposed to the sunshine;" therefore it was not, as is intended (and as is usually the practice of observers), sunk in the ground to the depth of 6 or 8 inches. (2) "Proper precautions were taken to keep the small pipe at the bottom of the funnel clear, so that there should always be a free communication between the air inside and outside of the gauge." The special object of this small pipe was thus reversed.

Without presuming to assign the relative or total effect due to each or both of these causes, there can be no doubt that each contributes to increase the loss given in Mr. Simmonds's Table, a Table which contributes materially to our scanty real knowledge of the subject, and which bears internal evidence of great accuracy of observation. Thus, the diameters of the can and glass being respectively 4·75 inches and 2·10 inches, their areas would be 17·7 inches and 3·5 inches; say, as 5 to 1, which closely approaches the relation subsisting between the loss from the two vessels—a loss which obviously depends simply on the rate of evaporation from a water-surface the ingress and egress of air to and from which is limited. The Table shows that this loss (even under the conditions above referred to) did not exceed 88 grains per superficial inch per month—that is to say, a layer about one-third of an inch in depth—or about one-twelfth of the loss which would have occurred had the funnel been entirely absent and the water fully exposed. I hope, however, no one will consider that such a loss as this occurs in general practice. I have taken as a test specimen the results obtained at Greenwich Observatory, where, since March 1861, two similar gauges have been kept side by side, one being read daily, the other monthly; and find the result of five years' observations to be:—mean from daily observations 24·354 in., and from monthly observations 24·366 in.; that is to say, they are sensibly identical.

Yours very truly,

G. J. SYMONS.

136 Camden Road.

P.S. I see Mr. Simmonds thinks the sentence on p. 224, vol. iii.

"loosely worded;" and so it is; but as a cursory notice of Letter I. few persons would, I am inclined to think, improve much upon it without greater prolixity: it could not very well give details not mentioned in the original.

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Session 1866–67,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., at [illegible]

1866.	November	21	1867.	March	[illegible]
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1867, JUNE 19.

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Vol. III. 1867, JUNE 19. [No. 32.

C. BROOKE, Esq., M.A., F.R.S., President, in the Chair.

The names of Three Candidates for admission into the Society were read.

CXLVII. *On the Diurnal Variation of Terrestrial Magnetism.*

By John Bloxam, Esq., F.M.S.

In a former communication some evidence was tendered in support of the proposition that the annual variations in the magnetic force are caused by the changes that occur in the aqueous element —that is to say, changes from and to the solid, fluid, and vaporous states. I propose now to show that there are grounds for attributing the diurnal variations to the same influence; but, in this case, evaporation and condensation are the only changes that have to be considered.

The authority here used for the diurnal variations is a paper communicated by the Astronomer Royal to the Royal Society on April 8, 1863: see the columns for "horizontal force" in the Tables on pp. 310–312 of the Philosophical Transactions, 1863.

Great force has a connexion with extensive land regions towards the north and an extensive sea-surface in more southern latitudes. This makes it appear that great force is caused by great condensation northward and great evaporation southward. Land, and especially mountainous land, must be characterized by condensation and deposition; and the sea must be characterized by evaporation. Deposition must exceed evaporation in land regions in high latitudes, and evaporation must exceed deposition in sea regions in low latitudes. Small force is, on the contrary, connected with an extensive region of land stretching from north to south. Small force therefore appears to depend upon small southern evaporation, small evaporation southward leading to small condensation northward. The mean force is connected either with a continuous line of sea stretching from north to south, or else with a great intermingling of land and sea in a north and south line, the sea being of moderate extent. Condensation and evaporation are each, in a great measure, dependent on the other; one of these cannot be very active (active and prolonged) whilst the other is inactive. The amount of force is much more uniform, through the day, when the sun is near the southern tropic than when he is near the northern tropic, the terrestrial surface being much more uniform in the southern hemisphere than it is in the northern hemisphere.

The lowest of the low values for horizontal force are much more in defect than the highest of the high are in excess. Whilst the *minus* quantities in Table I. are thirty-one in number, the *plus* quantities are fifty-three; and in Table II., the *minus* quantities being fifty-seven, the *plus* quantities are eighty-five. Conditions favourable to terrestrial magnetism are therefore the rule, and those unfavourable to it the exception; that is to say, sea in the more southern latitudes and land in the northern latitudes constitute the prevailing condition of the surface of the earth; and if the land and sea were not thus distributed, we should lose much of the moisture we now have the benefit of, and with the moisture we should lose heat also, in northern latitudes. If land had been massed in equatorial (torrid) regions, and the sea in polar (frigid) regions, the world, as a residence for organized creatures, would have been totally different from what it actually is. The land, under such circumstances, would not receive more moisture from the atmosphere than it gave to the atmosphere. Vapour yielded by the land would be conveyed to the sea in the higher and colder latitudes, and the land would thus become dry desert.

TABLE I.

Hours for Göttingen	0	2	4	6	8	10	12	14	16	18	20	22	Sums.	Range.
Long. from Greenwich	E. 9½	W. 20½	W. 50½	W. 80½	W. 110½	W. 140½	W. 170½	E. 159½	E. 129½	E. 99½	E. 69½	E. 39½		
1841	−123	−53	+10	+32	+52	+42	+39	+33	+28	+43	− 3	−105	563	175
1842	−102	−23	+33	+45	+58	+36	+38	+12	− 4	+10	− 2	− 92	455	160
1843	− 87	+ 2	+42	+53	+52	+36	+25	+ 1	− 3	+ 1	−29	−110	441	163
1844	− 92	+ 6	+53	+80	+78	+49	+27	− 3	−13	−13	−51	−108	573	188
1845	−103	+10	+55	+62	+61	+43	+31	+ 1	− 3	+ 1	−40	−118	528	180
1846	−114	−12	+53	+83	+72	+48	+29	+13	+ 2	+ 8	−39	−133	606	216
1847	−119	−16	+41	+67	+73	+52	+34	+ 3	+ 8	+ 8	−24	−120	565	193
Means	−106	−12	+41	+60	+64	+44	+32	+ 9	+ 2	+ 8	−27	−112	533	182
Range	36	63	45	51	26	16	14	36	41	56	49	41	165	56

TABLE II.

Hours......	0	2	4	6	8	10	12	14	16	18	20	22	Sums.	Range.
January ...	− 47	+ 5	+17	+ 8	+ 2	− 2	−17	−20	−13	+35	+ 43	− 2	211	90
February	− 46	+ 7	+26	+ 29	+ 29	+ 4	+ 1	−26	−17	+17	+ 27	− 30	259	75
March......	−109	− 3	+56	+ 47	+ 47	+30	+30	− 1	−11	+ 7	− 4	−101	446	165
April	−160	−39	+56	+ 84	+ 77	+50	+44	+30	+10	+21	− 19	−164	754	248
May	−134	− 9	+66	+113	+119	+70	+43	+14	− 6	−23	− 86	−167	850	286
June	−130	−10	+57	+101	+110	+71	+51	+26	+11	−11	−106	−173	857	283
July	−146	−20	+73	+109	+120	+77	+54	+14	− 3	−11	− 90	−170	887	290
August ...	−141	−11	+66	+ 89	+ 99	+83	+59	+33	+11	−14	− 83	−190	879	289
September	−141	−16	+39	+ 53	+ 71	+63	+54	+37	+23	+20	− 49	−170	736	241
October ...	−120	−27	+17	+ 37	+ 50	+53	+41	+21	+27	+26	0	−121	540	174
November	− 63	−14	+11	+ 33	+ 26	+13	+10	0	+ 1	+19	+ 19	− 51	260	96
December	− 43	−10	+13	+ 21	+ 14	+ 9	+ 4	−29	−14	+19	+ 26	− 6	228	69
Means......	−107	−12	+41	+ 60	+ 64	+43	+31	+ 8	+ 2	+ 9	− 27	−112	576	192
Range......	117	46	62	105	118	85	76	66	44	58	149	188	676	215

NOTE.—The values which are expressed in decimals in the Tables of the Astronomer Royal are introduced as whole numbers in the above Tables.

The Tables I. and II. show that the hours 4 to 14 may be regarded as hours of excessive force, and the hours 20 to 2 as hours of defective force. During the former interval, North America and North-eastern Asia constitute the condensing-grounds for the vapour yielded by the Pacific. The meridians 50° 26′ W. and 159° 34′ E. from Greenwich correspond, respectively, with the hours 4 and 14. The months December, January, and February, however, are marked with defective force at 14^h; and a reason may be found for such exceptional values. In December, the sun's position at 14^h is on the east side of Australasia and in the midst of the Polynesian Islands, and the land on his north side is here of small extent compared with that of the sea. The conditions are much the same in January and February; but temperature is at its lowest in these months, in the northern hemisphere, and at its highest in the southern hemisphere; there may, therefore, be somewhat more of northern condensation of southern vapour in these months than in December. During the other period, marked by defective force, viz. 20ʰ to 2ʰ, the sun passes from 69° 34′ E. to 20° 26′ W. from Greenwich. This range may be said to include Europe and Africa, and to constitute, at the medium line, a land meridian from the north of Europe to Southern Africa. November, December, January, and February are exceptional months in this category, at 20ʰ, but they are so in a contrary sense to that specified for the category of excess. The explanation is similar; the conditions are reversed: the sea surface under the sun's (nearly) vertical rays at about 20ʰ increases as the sun approximates to the southern tropic, land still existing on the north side of his position; and thus the conditions become more favourable to magnetic action; a similar state of things is observable at 22ʰ, defect *almost* disappearing in December and January at this hour; and this is what the correlative positions of the sun and the east coast of Africa might lead us to expect. The greatest defect at 20ʰ occurs in June; and the sun's rays, at this hour, in this month, tell with force and effect upon a vast northern land region, and with comparatively small effect upon the southern sea; land diminishes towards the southern tropic, the sea disappears at the northern tropic. The hour 2 is marked in the Tables as one of defect, and it has therefore been included here in the category of defect; but there is room for doubting whether, in fact, there be defect at this hour, as will presently be explained. The transitions between 0ʰ and 4ʰ are interesting. At 0ʰ the sun has just passed over a very extensive land region, and the force is at a very low value; at 2ʰ he is on a meridian of sea extending almost from pole to pole, and the force at this hour rises to, or nearly to, the mean; at 4ʰ land is brought to the north side of his position, and the force is there in excess. At 2ʰ the surface in northern latitudes is not favourable to condensation, and the vapour therefore remains and accumulates in the atmosphere, and evaporation is thus checked in the more southern latitudes. Under all the circumstances it may be confidently assumed that the actual mean occurs at some time between 0ʰ and 4ʰ,—that is to say, whilst the sun is passing from western Africa to eastern America, whilst he is on a meridian of continuous sea.

The maximum force occurs on the average at 8ʰ—the values being taken at two-hour intervals. The position of the sun at 8ʰ is 110° 26′ W. from Greenwich, and this is a meridian of somewhat remarkable character. If we look to 7ʰ 45ᵐ, instead of 8ʰ, or 106° 41′ instead of 110° 26′, this meridian runs through Mexico and the midst of the mainland region of North America—that is to say, midway between Hudson's Bay and the western coast of America, the land reaching northward to the Arctic Circle; it crosses the Rocky Mountains, running nearly in the same line with them, and for some 10° of latitude in the same line. It runs close to the spot (in lat. 63°) where the temperature − 70° Fahr. has been observed; and this is, I believe, the lowest temperature on record for the atmosphere. At 7ʰ the sun crosses the meridian of the north magnetic pole as this was determined by Sir James Ross; and it is worth noting that this meridian of the magnetic pole passes through the Gulf of Mexico, the great fountain of vapour. Considering the local conditions, it might be expected that at 7ʰ 45ᵐ, at a certain period of the year, there would be more active evaporation going on between 95° 26′ W. and 106° 41′ W. than there is at any other time or place. The ocean extends between these meridians from Mexico to the Antarctic Circle. The region of the most extreme cold in the north seems to be within the same range. The greatest excess given for the horizontal force, in the Tables I. and II., is that for 8ʰ and for July, and the excess for May at the same hour is nearly as great, though that for June is less. When the sun has extreme north declination, his path is overland whilst passing from 95° 26′ to 106° 41′, and the evaporation may therefore well be less in June than in May and July. The periods of the year at which the greatest evaporation might be expected to occur are about a month before and a month after the summer solstice; and it is to be supposed that the maximum would be at the second of these periods. The summer months (of the northern hemisphere) contribute the most to make up the maximum at 8ʰ. Whilst May, June, and July contribute on the average a quantity equal to + 116, November, December, and January contribute + 14. Moreover, though the five months May, June, July, August, and September each give their maximum force to 8ʰ, the other seven months do not adhere to this hour for the maximum. The force is much less in these seven months than in the five, the highest value in the seven months (that for April) being only slightly above the lowest of the five (that for September); and the time of the maximum is less pronounced. Now in the summer months the sun passes over a surface of sea from the west side of Africa to the east side of Asia, with the whole length of North America on his north side at 8^h^. But in the winter months the conditions are different; the sun in this period of the year passes over South America, and the maximum seems to occur upon the sun reaching the Pacific, and, consequently, at an earlier hour than it occurs at in the summer. In four months out of the seven winter months specified the maximum is given to 6^h, in two to 4^h, and in one it is given to 10^h. The values of these divergent maxima are low, as well as the minor values that occur at 8^h in these seven winter months, the highest maximum alone in this category of winter months being higher than the lowest of those in the category of summer months. The low values of these exceptional maxima may be, in part, the result of the vapour being drawn eastward to the line of mountains on the west side of South America, instead of proceeding northward over North America.

The minimum is shown by the Tables to occur on the average at 22^h, and at this hour the sun is 39° 34′ E. from Greenwich; he may therefore be said to have reached the east side of Africa at this hour, and to be opposite to a meridian in which land extends from the Arctic Circle to the Tropic of Capricorn nearly. The force declines very rapidly between 20^h and 22^h; and this accords with the difference in the nature of the surface the sun passes over at these two hours. At 22^h the sun may be said to pass from the Indian Ocean to the continent of Africa, a change the reverse of that which is connected with the accession of the maximum. The maximum occurs in connexion with a sea surface beneath and to the south of the sun, with land and high mountains on his north side; and the minimum occurs in connexion with land stretching southward as well as to the north, with its principal range of mountains crossing the Equator. But although 22^h gives, on the average, a greater defect than any other hour in the Tables, it appears probable that the minimum really occurs nearer to 23^h than to 22^h, and that 23^h gives a lower value than 22^h. The three months June, July, and August give a mean defect of 178 at 22^h; but December, January, and February give a defect of 13 only at this hour. Five of the months, viz. November to March, give the minimum at 24^h; and the mean defect for these months is 62 at this hour, the remaining seven months giving the minimum at 22^h; but whilst the mean defect for these seven months at 22^h is 165, it is as much as 139 at 24^h. This renders it probable that between 22^h and 24^h the force is, in fact, on the whole, less than it is at

22^h. Now at that period of the year in which the sun is near the southern tropic he is vertical to a sea surface at 22^h; but at 23^h he crosses southern Africa, and there are mountain-ranges east, west, and south of his position; the evaporation may therefore be assumed to be less at 28^h than at 22^h, and the condensation is likely to occur eastward, westward, and southward; and this leads to the conclusion that the defect in the horizontal force may be great at 23^h at this period of the year, although it is small at 22^h. Supposing the strength of the magnetic force to be regulated by the influence of land and of sea in the sense referred to, and considering the position and inclination of the eastern coast of Africa and Arabia, it might be expected that the minimum force would occur at a *progressively* later hour as the sun's declination progressed from north to south, and *vice versâ*; accordingly, if we look to the successive months and compare 22^h with 24^h, we get the following results:—

				h
July	Defect	24	less at	24
August	„	49	„	„
September	„	29	„	„
October	„	1	„	„
November	„	12	greater	„
December	„	37	„	„
January	„	45	„	„
February	„	16	„	„
March	„	8	„	„
April	„	4	less	„
May	„	33	„	„
June	„	43	„	„

The defect is greater, at each of these two hours, when the sun is near the northern tropic and crosses a wider extent of land than when he is near the southern tropic, where the land is of small extent and the sea of great extent. In June the defect is as much as 106 at 20^h, the sun having at this time just crossed over the north of Hindostan.

The nearest approach to the mean force appears at 16^h. At this hour the sun is 129° 34′ E. from Greenwich; and this is a meridian remarkable for a great intermixture of land and sea, with land massed, however, in the far north. The force at 16^h is, according to the Tables, a trifle above the mean value. At 14^h and at 18^h the force is, on the average, nearly the same as at 16^h; but the excesses and defects, as given by the several months, are very differently distributed in the several columns of Table II. for 14^h, 16^h, and 18^h. At 14^h *plus* quantities accumulate towards the summer months; and at this period of the year, at this hour, the North Pacific yields vapour abundantly in the region south of the easternmost part of Asia. At 16^h *plus* and *minus* quantities are distributed over the year in no very definable order; but the *minus* quantities preponderate in the winter months, when the sun is either crossing or to the *north* of Australia. At 18^h *minus* quantities accumulate in the summer months; and at this hour and season the continent of Asia is brought more especially and exclusively under the sun's power.

The next nearest approach to the mean (that at 2^h) occurs when the sun is opposite to a sea line from pole to pole, with a large continent both on the east and on the west side. The value at this hour is a little below the mean, according to the Tables; but if the force be, in fact, lower at 23^h than at any hour given in the Tables, the values for 2^h may be, in fact, not below the mean; and the value for 16^h would then be more above the mean than the Tables show.

The column of "sums" in Table II. shows that there is a much greater diurnal inequality of force in the summer months than there is in the winter months, and that the monthly increase and decrease of this inequality are very regular. The progression in this respect appears to conform to the progression of temperature more than to that of the sun's declination; for if July and January are taken as the poles, there is, then, greater symmetry on the two sides of the poles than there is if June and December are taken as the poles. Taking July and January as the poles, and pairing the other months in succession, as below, the results are rather suggestive. The mean for the pair is given to each pair.

January	211
December February	243
November March	353
October April	647
September May	793
August June	868
July	887

In every instance, the difference between the two months constituting a pair is less under this arrangement than it is in the corresponding pair under the other arrangement; and it may be observed that in each of the *ten* pairs the second of the pair has the highest number, with the exception only of the last in the list given, and the difference in this is less than in any other pair. In parallels near to the northern tropic there is great diversity in the terrestrial surface, but in parallels near to the southern topic there is much greater uniformity of surface.

The daily range of the force has a progression very similar to that just noticed; and the months on the spring side of the year give higher numbers than those on the autumn side in this particular also, with the exception, again, of the last pair. The following are the progressive values for the daily range. December and February, however, here, each give irregular low values.

January	90
December	72
February	
November	130
March	
October	211
April	
September	263
May	
August	286
June	
July	290

The annual range of horizontal force, as shown by the monthly values in Table II., is least at the hours of mean force—that is to say, at 16^h and at 2^h; the force is nearly the same at these two hours at all parts of the year. The hour of the minimum force, viz. 22^h, gives the greatest range, the force being greatly in defect at this hour when the sun is near the northern tropic, and only slightly in defect when he is near the southern tropic. The range is great, in like manner, at 20^h and at 24^h; but it may be otherwise at 23^h. The hour of the maximum force, viz. 8^h, gives a great range, the force being greatly in excess when the sun is near the northern tropic at this hour, and only slightly in excess when the sun is near the southern tropic. The secular variation for the seven years, as shown by Table I., is comparatively small, no hour giving a high number for range. The mean diurnal range is below the mean for the seven years in the first three years, and above it (almost constantly) in the last four years; but the range in the last year is, nevertheless, but little above that for the first.

CXLVIII. *The Anemometric Records of the Greenwich and Kew Observatories Epitomized and Collected.* By Colonel Austen F.M.S.

Thanks to modern ingenuity, and the wonderful accuracy of scientific mechanism, meteorologists possess now that great desideratum, anemometers, whose continuous and almost infallible action, by day and night, are made self-interpreters of the gentlest and heaviest winds alike; whilst their force and direction are also duly traced, with the accuracy of photography nearly, on cylindrical rolls attached to these instruments.

In No. 30 of the Meteorological Society's 'Proceedings,' a most valuable paper appears, from the pen of J. Glaisher, Esq., F.R.S., giving us a series of wind-tables, having reference to the several lunations from 1841 to 1847 inclusive. On comparing these tabular results with the Kew anemometric records from 1862 to 1867, I find a striking resemblance of results; and when we have it made so evident as it is by these automatic and self-registering instruments that, for years together, the winds have a characteristic type, of polar or equatorial tendency, according as the moon is on the equator, or at either tropic, in each lunation; the conclusion seems legitimate *that a connexion does* exist between *that* luminary and our atmosphere, which, inasmuch as it raises constantly the ponderous waters of the ocean *beneath* the atmospheric strata, may well be presumed to influence also by gravity no less than by electric attraction, or repulsion, the suprajacent *atmosphere itself.*

That foreign physicists have mostly maintained the non-existence of such a connexion, I well know; but their reasons and tabular statistics have never satisfied me on the point; and now these Greenwich and Kew wind-records confirm me in the conviction I have for years entertained as to the general parallelism of the moon's orbital movements and the shifts of wind, as regards at least the general character of such, and their force, too, more or less, at each lunation—the sun's position in the ecliptic influencing and modifying the same always, according to the season of the year.

A study of Tables will, I trust, convince all unbiased persons of this solilunar connexion, and enable them hereafter to predict with average accuracy the character of the coming wind, according to the age of each individual moon, and her inclination, allowing from 36 to 48 hours' interval for the due operation of this twin influence on the earth's atmospheric *inertia.*

The above reasoning applies chiefly to the north temperate regions of our globe, being *en accord* with the instrumental teachings of Greenwich and Kew respectively, but will apply, I have no doubt, to the south temperate zone also—its physical and geographical features modifying the same, of course.

CXLIX. *Ideas on the right Mode of Observing and Interpreting Barometric Fluctuations.* By Joseph John Murphy, Esq.

1. It is easy and convenient to represent fluctuations of any kind by means of wave-like curves; and these curves are often called waves. We speak of thermometric waves and barometric waves.

2. But in speaking of barometric waves it appears to be usually taken for granted that barometric fluctuations are due to actual waves of atmosphere—waves in the proper dynamical sense of the word. I submit that this ought not to be so taken for granted, and that to do so is an instance of the logical error of bringing in an assertion as to a matter of fact, in the disguise of the definition of a term. Barometric fluctuations are probably due to such *true atmospheric waves* in many cases, but, as I think I can show, not in all.

3. If any given barometric fluctuation is due to the passage, over the station, of a *true wave*, another barometer at a height of, say, 12,000 feet vertically above the first should show the same fluctuation, though probably of less magnitude.

4. But this is not always observed. It is of course impossible to find one station 12,000 feet vertically above another; but it is easy to find mountains and lowland stations near enough for comparison. According to 'Kaemtz's Meteorology' (English translation, page 256), "Whilst on the plains the barometer generally falls during the day, it does the contrary on an elevated summit." The reason of the rise in the barometer above is, that the whole column of air is lifted up by expansion due to the heat, so that a larger portion of the column is raised above the mountain station; and the reason of the fall in the barometer below is, that the summit of the column, being raised to a higher level than the neighbouring masses of air, flows out horizontally over them, and so lightens the pressure on the barometer below.

5. It may be safely stated that, if the fluctuation above is in the contrary direction to that below, they are not due to a *true wave*, and that it is impossible to be certain of the interpretation of barometric fluctuations, unless we know whether the fluctuation above is in the same or the contrary direction to that below.

6. So far as I can see, knowledge on this subject is only to be had by observations; and these must be made for the special purpose.

7. Balloon ascents would be useless, because in them we have to infer the altitude from the barometric pressure, and what we want to do is to compare the pressure with the altitude.

8. No mountain in the North of Europe is high enough.

9. The objection to the Alps is that they are so great a mountain-mass as to give origin to local air-currents and fluctuations; and what we want is information about the great undivided aërial ocean.

10. Teneriffe is in the trade winds; and the information we want is concerning the variables.

11. Etna is high (12,000 feet), isolated, and in the variables. I think that comparative barometric observations, continued hourly for two or three years at the summit and at the base of Etna, would throw great light on this as yet unexplored subject. Of course temperature, force, and direction of the wind, &c. should be registered at the same time. Such a series would certainly have high scientific interest, and possibly great practical utility, by giving help to the art of predicting the weather.

TO THE EDITOR.

Evaporation from Rain-Gauges.

SIR,—In the April No. of the 'Proceedings' there is a letter from Mr. Symons, in which he professes to give a short chronological account of the recent discussion on the evaporation of rain from rain-gauges. His object in writing, he says, is that facts may be clearly stated and that persons may not be credited with opinions they never held. Most unfortunately Mr. Symons has forgotten to mention, in its proper place, a communication made by himself to the Society, and printed in p. 224 of Vol. III. of the 'Proceedings.' I say "most unfortunately" omitted, because it has the appearance of having been done intentionally, as the facts stated in that communication are directly opposed to the opinion now expressed in his letter.

In the same letter, after referring to my experiments on the evaporation from rain-gauges, Mr. Symons says, "The Table shows that this loss (even under the conditions above referred to) did not exceed 88 grains per superficial inch per month—that is to say, a layer about one-third of an inch in depth—or about one-twelfth of the loss which would have occurred had the funnel been entirely absent and the water fully exposed. I hope, however, no one will consider that such a loss as this occurs in general practice." What Mr. Symons's hopes are, it would be difficult to say exactly; but if he wishes his readers not to put any faith in the observations, it is odd that he should have declared that they bear internal evidence of great accuracy. And if he merely intends them to understand that the loss from evaporation will be very small with gauges properly constructed and fixed, and read daily, he should, after saying the Table shows, &c., have quoted the following words from my paper—"The error due to evaporation in the rainfall measured will therefore be very small, if the gauge be properly constructed and read daily;" and then he would not have misrepresented the results derived from my experiments.

The coincidence of the readings of two gauges placed side by side, one read daily and the other monthly, is no proof that the error arising from the evaporation of the rain from gauges is so small that it may be neglected, but merely of the fact that the sum of the errors made in repeatedly measuring small quantities was equal to the loss from evaporation in that particular instance. I take it for granted, as stated, that similar gauges were used, and that the mean rainfall for the five years is 24·354 in. from the gauge read daily, and 24·366 in. from the gauge read monthly, although for the year 1866 the result is just the reverse; for the fall from the gauge read daily is 30·72 in., and from that read monthly 30·09 in.

In speaking of the position of the gauge used by me in making my observations, Mr. Symons says, "therefore it was not as is intended (and as is usually the practice of observers) sunk in the ground to the depth of 6 or 8 inches." It is quite true that the gauge was not sunk in the ground, nor was it intended that it should be, as the object of the experiments was to obtain the maximum effect due to evaporation. But it is not true that the practice usual with observers is to sink their gauges partly in the ground—at least, if all those whose observations are published in the "British Rainfall" are to be considered observers; and moreover, a modification of Howard's rain-gauge, arranged by Mr. Symons, and described in Messrs. Negretti and Zambra's 'Treatise on Meteorological Instruments,' is especially designed to stand on the ground, and one can hardly suppose that the gauge was not intended for use. The pipe at the bottom of the funnel was kept clear, and its special object, as intended by Mr. Glaisher, no doubt reversed; but then the gauge probably resembled those employed by some observers more than it would have done had the pipe not been kept clear, as Mr. Symons says (in one of his publications) that he always straightens the pipe, which would allow free communication between the air inside and outside the gauge. It will be seen from the above, that the conditions under which my experiments were carried on were not altogether so different from those under which it is the usual practice of observers to make their observations.

Yours truly,
G. HARVEY SIMMONDS.

Penge, 16th June, 1867.

Rainfall in New Granada.

SIR,—My friend, Mr. R. S. Illingworth, who was resident in Bogotá, in New Granada, South America, from 1822 to 1842, has recently placed in my hands some statistics as to rainfall in New Granada, which I have his permission to present to the Society for publication in its 'Proceedings,' if the record be thought of value.

The records of the rainfall measured at the Marmato Mines, lat. 5° 29′ 19″ N., at an elevation of 4836 feet above the sea, extend over fifteen years, viz. from 1833 to 1847.

Those of the rainfall at S. Ana extend over five years, 1838 to 1842; and those at La Baja, lat. 7° 22′ 17″ N., long. 72° 30′ W., and at Bogotá at an elevation of 8958 feet above the sea, extend over six years (1837 to 1842).

The measurements at Bogotá were made by Mr. Illingworth personally, and the others by assistants at establishments which were under his direction.

I am, Sir,
Your obedient Servant,
D. A. FREEMAN.

Temple, 18th June, 1867.

MARMATO.

Year.	Quantity, in inches.
1833	59·3
1834	72·1
1835	117·8
1836	100·0
1837	88·4
1838	113·4
1839	93·5
1840	73·8
1841	82·1
1842	55·1
1843	64·8
1844	88·4
1845	70·5
1846	88·3
1847	92·0
Average	90·0

S. ANA.

Year.	Quantity, in inches.
1838	62·0
1839	85·4
1840	53·7
1841	94·0
1842	67·7
Average	72·5

LA BAJA.

1837	52·9
1838	68·8
1839	50·6
1840	37·5
1841	64·9
1842	50·3
Average	54·1

BOGOTÁ.

Year.	Quantity, in inches.
1837	42·0
1838	51·4
1839	35·9
1840	44·8
1841	48·6
1842	40·0
Average	43·8

ANNUAL GENERAL MEETING.

1867, June 19.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held; and the following Report of the Council was received and read.

REPORT.

The Council, in presenting the following Report, cannot refrain from expressing their satisfaction at the continued prosperity of the Society, and likewise at the satisfactory state of meteorological science in all quarters of the globe. The papers bearing upon meteorology which have been read at the various Meetings of the Society, and especially those upon meteors (which, after having been catalogued for so long a period by meteorologists, seem now to be passing out of the field of meteorology into that of astronomy) have been very numerous and interesting.

The Reports which follow, from the several meteorological observatories and institutions which have, as in preceding years, reported their labours to us, render it unnecessary for the Council to dwell longer upon the state of meteorology, as they are convinced that such information may more readily be gleaned from the Reports themselves than from any general and consequently imperfect statement which they could present.

Royal Observatory, Greenwich.—The Magnetical and Meteorological Department of the Royal Observatory has continued to carry out with undiminished vigour the objects for which it was founded, and in this course of persevering and unswerving steadiness is worthy of close imitation by all observers. The principal changes in its buildings and instruments, and details concerning its practical working, during the past year, will be found in the following remarks.

The Magnetic Basement has been perfectly dry, and its walls are in a very good state. Considerations of temperature and of photogenic action have shown that greater ventilation was sometimes required; and it has been found necessary to fix a larger ventilation-tube (passing through the upper room) with section about double of that formerly used, and with cowl of corresponding dimensions. With this tube, and means of partially closing the aperture, the use of the gas-stove, and with the ordinary management of windows and shutters, the command of temperature and of photogenic action is practically perfect.

The ground-plan of the building was accommodated to the direction of terrestrial magnetism in 1837. In consequence of the N.W. and S.E. direction of magnetic declination, the south-easterly reentering angle of the building, to which the horizontal-force magnetometer is near, receives less of the sun's rays than are received by the south-westerly reentering angle, to which the vertical-force magnetometer is near; and in consequence of this, the latter instrument is usually between 1° and 2° warmer than the former. To produce a greater equality of heat it will be necessary to shift the gas-stove, which at present is equidistant from the two instruments, a little nearer to the horizontal-force magnetometer.

The control of the Magnetic Basement, during the past year, within the limits between which it is desired to keep it, has required very great judgment and care. The annual change, though greatly diminished, cannot be annihilated. The diurnal change can be made in moderate weather almost insensible; and even in severe heat can be kept within 3°. An injudicious practice pursued during the hot summer of 1865 caused great diurnal changes; but care has been taken to guard against a repetition of this.

It is to be remarked that the question is not a simple one of thermometric heat. For the efficiency of photography, ventilation is necessary, and moderate temperature is desirable. The problem of securing these, with uniformity of warmth, is in practice rather difficult.

Magnetic Instruments—Magnetometer &c. The upper declination-magnet is in good order. The water in which its quieting brass bar vibrates was frozen in the winter, and the bar was then detached for a time.

The theodolite by which the magnetic indications are referred to the astronomical meridian is in good condition.

The lower declination-magnetometer for continuous photographic registration of magnetic declination, is in perfectly good order.

In our last Report allusion is made to intended experiments on the effect of an oval copper damper upon the magnitude of disturbance produced in the place of the declination-magnet by a given external cause. The experiment is not easy, inasmuch as, when the damper is removed, there is in ordinary mountings no quieting agent, and a magnet must therefore be used which has the rather troublesome combination of damper and quieter. These experiments have, for this reason, not yet been proceeded with.

The horizontal-force magnetometer, for continuous photographic registration of magnetic horizontal force, is in good order.

The vertical-force magnetometer, for continuous photographic registration of magnetic vertical force, is in good order. In its photographic sheets for the last year, there occur two instances of dislocation of curve,—one on 1866, July 9, of which we can give no explanation; the other on 1867, January 2, when the other magnets were under annual adjustment, and were withdrawn from their supports and again inserted. The knife-edge has not been specially revised, but appears to be in good order.

The thermometrical corrections of the horizontal-force and vertical-force instruments have not been reinvestigated since our last Report; but it is probable that they will be redetermined by heating the basement as far as the gas-stove will permit, leaving the two instruments in their mountings; but, for advantageous use of this method, with due contrasts of temperature, it will be necessary to wait for winter.

All observations made with the three magnetometers are kept constantly reduced, and the photographic records are likewise in forward stages of reduction. The mean westerly declination for the year 1866 is about 20° 28′, showing a decrease of about 7′ from the preceding year.

The instrument for continuous photographic registration of spontaneous earth-currents is in perfect action, and the earth-currents have been constantly recorded, with none but accidental interruptions.

For these records, the time-scales are laid down on the photographic sheets to 1866, December 31. The number of these records now ready for discussion is sufficiently large to make it incumbent soon to take some steps for their examination.

The dip-instrument is in very good order. The needles have not been specially revised. The mean dip for 1866 is 68° 1½′, and at the present time it is about 67° 58′.

The deflection-apparatus is in very perfect order; and the mean value of the horizontal force for 1866, as found by its use, is about 3·841 in English units, and in French units about 1·771.

Meteorological.—The meteorological instruments, whether those read by eye for indications at the moment, those read for definite-part registers, those which give continuous mechanical registers, or those which give continuous photographic registers, are all in good order. They include barometers, dry and wet air-thermometers, radiation thermometer, thermometers in the Thames, Osler's and Robinson's anemometers, Osler's and six other pluviometers. The photographic barometer has lately shown a tendency in its indications to "jump," indicative of some friction which has been investigated and corrected.

In Osler's anemometer, a surface of 2 square feet is now exposed to the wind instead of 1 foot as formerly; and the plate is supported by weak vertical springs instead of rods running on rollers. Its indications are much more delicate than formerly. This change was made by Mr. Browning, and is described by that gentleman in the 'Proceedings,' vol. iii. p. 335.

The annual rotations of the vane still present the appearance of a septennial period. At the risk of some repetition, the following Table of rotations through twenty-six years is presented, that of 1845 being augmented in the proportion of ten and a half months (through which the observations extended) to twelve months, and the sign + being understood to mean in the direction N., E., S., W., N.

		1846	+ 1·8	1853	− 1·9	1860	− 2·1
		1847	+ 11·0	1854	+ 6·8	1861	+ 16·5
1841	+ 5·4	1848	+ 12·1	1855	+ 10·8	1862	+ 13·7
1842	+ 13·1	1849	+ 23·3	1856	+ 16·1	1863	+ 28·4
1843	+ 20·7	1850	+ 15·9	1857	+ 14·7	1864	+ 17·2
1844	+ 21·7	1851	+ 19·1	1858	+ 24·1	1865	+ 26·0
1845	+ 10·0	1852	+ 8·8	1859	+ 14·0	1866	+ 15·4

With the new pressure-plate of Osler's anemometer, the pressures per square foot registered in the last six months are larger than any that have been before recorded. Whether any part of this is due to the circumstances that the plate is larger and its motion easier, or whether it is wholly due to the great violence of the wind in this stormy season, cannot yet be determined.

With Robinson's anemometer there is connected a revolving barrel (moved by clockwork) covered each day by a sheet of paper, on which a pencil carried by the anemometer makes a trace, exhibiting continuously the speed of the wind and the aggregate of its motion. This apparatus also was made by Mr. Browning, and is fully described by him, with explanatory drawings, in the 'Proceedings,' vol. iii. pp. 334, 335.

The indications of the electrical apparatus are still feeble and partial. The actinometer has not maintained its adjustments well.

All the meteorological instruments have been constantly at work for their respective determinations; and all meteorological observations are cleared of instrumental errors and instrumental constants. Errors of thermometric scales are applied to the present time. Time-scales for photographic registers of barometer and thermometers, and new base-line for barometer, are formed to 1866, December 31. The sheets of Osler's and Robinson's anemometers are adjusted with care on every day's application, and require nothing further.

Daily communication is made to M. le Verrier for his meteorological bulletin, and weekly communication to the Registrar-General for his sanitary Report.

The Meteors on November 14 were well observed; eight thousand three hundred were registered. The variations of frequency at different times were very well noted, and the points of divergence were carefully determined.

The indications of magnetometers are printed to the month of August 1865, and the whole manuscript is in the hands of the printers. The deflection-observations and dip observations are completely printed. A new introduction was drawn up with much care; but it has required various additions, which have delayed the complete printing.

The meteorological observations are printed in their usual form; they include actinometer observations, and meteor observations, especially of the conspicuous shower of 1865, November 13.

The impression of the Magnetical and Meteorological Observations is 600 copies, of which 350 copies, are to be attached to the same number of the Astronomical Observations, and 250 retained for separate distribution.

It is customary to take two photographic copies of each of the magnetic photographs. They remain, however, in the same state as at the last Report, *i. e.* complete to the end of 1863. The declination and horizontal-force photographs for 1864, which I considered to be vitiated by the faults of suspension, are not copied; nor will those of vertical force be copied. And no progress has yet been made with those of 1865 or 1866.

For 1866, the vertical-force -indications are ready for press to March, the thermometer-readings for horizontal force and vertical force to December 31; dip abstracts also are formed to the same time. Of the meteorological observations, the greater part could be put at once into the printers' hands.

In the reduction of the magnetometer-indications 1858–1863, the staple of the work on diurnal inequalities and lunar inequalities is quite finished, some examination being still required. The storm-days are not yet touched. Although a special grant of money was made last year for the carrying on of these reductions, yet much of the ordinary strength of assistants was employed on it, and the ordinary reductions have in some measure suffered.

The Astronomer Royal, from whose Annual Report the preceding remarks have been principally derived, concludes that document with the following remarks on the subject of magnetical and meteorological observations and their reduction, as carried out at the Royal Observatory:—

"It seems scarcely necessary for me to state that, from the first day on which I took charge of an Observatory, it has been my determination to present all results of astronomical observation in a form as far reduced as possible. The history and nature of the subject indicated clearly the course to be followed; and there remains little to be added at present, except to compare the rather widely separated catalogues of the principal stars, and to correct the elements of the large planets.

"Subsequently the subject of magnetism was introduced into this Observatory; and, after clearing all observations of instrumental errors, it seemed difficult to say, amid the bewildering irregularity of continuous results, what following step would be best. I at length decided on the investigations which are published in the Philosophical Transactions—'On the Diurnal Inequalities' (which include the exhibition of annual inequalities &c.), 'On the Lunar Inequalities,' and 'On the Analysis of Magnetic Storms;' and I am so well satisfied with the light which these seem to cast on magnetic phenomena, that my present intention is to go on in the same way until I see reason to make change or addition.

"But I have felt myself unable to decide on any plan for the further treatment of the meteorological observations, which were introduced at the same time as the magnetic observations. The present time, however, in which so many meteorological observatories have suddenly sprung up and have commenced printing their observations in detail, seems a proper one for considering this subject. Whether the effect of this movement will be that millions of useless observations will be added to the millions that already exist, or whether something may be expected to result which will lead to a meteorological theory, I cannot hazard a conjecture. This only I believe, that it will be useless, at present, to attempt a process of mechanical theory, and that all that can be done must be to connect phenomena by laws of induction. But the induction must be carried out by numerous and troublesome trials in different directions, the greater part of which would probably be failures.

"All the investigations of which I have spoken imply considerable increase of expense, probably least for the first head and greatest for the third. And it is, as I conceive, a proper subject for the consideration of the Board of Visitors, and one on which I should feel myself bound to respect their opinion, how far those investigations should be encouraged. The doubt, perhaps, will attach mainly to the last of the three, in which the course to be followed is so obscure, and the expectation of success so little founded. Still it is not to be put out of view that the Observatory possesses perhaps the richest collection of accurate meteorological observations which exists, and that whatever is to be done, either now or at some future time, can probably be placed upon a better foundation by use of the Greenwich observations than by any other."

ROYAL OBSERVATORY, EDINBURGH.—1. The principal meteorological work performed here during the past year has been the computation of the observations made at fifty-five stations of the Meteorological Society of Scotland, for the purposes of the Registrar-General of Births, Deaths, &c. in North Britain, and published by him in his Monthly and Quarterly Reports.

2. Records of the deep-soil thermometers with their bulbs sunk at various depths in the rock of the Calton Hill, from 3 to 300 inches, together with a small journal for instrumental purposes, have been kept up as in former years.

3. In the second volume of his lately published book, 'Life and Work at the Great Pyramid,'—the Edinburgh Astronomer has printed the whole of his meteorological journal when living at the Great Pyramid in 1865, to the extent of 50 pages; and in the 20 following ones has given a discussion of the numbers, so far as concerns bringing out correctly the mean results for the period and comparing them with similar leading features in the climate of other countries; while in the 3rd volume of the same work there is an inquiry, extending through 24 pages, relative to the ancient standard of temperature in the Great Pyramid system of weights and measures, and the suitable graduation of its scale. The actual temperatures observed by the author within the Great Pyramid, differ nearly 7° from the theoretical amount expected; but he shows, more or less satisfactorily, that nearly the whole of

that difference is due to the anomalous circumstances of the building's interior in the present day, with its ancient ventilating channel stopped up, and its supply of watery vapour cut off. Exactly what amount of correction is due to those circumstances, he does not attempt to give an authoritative opinion upon; but he shows that *some* correction on that account is just as necessary there as to correct a raw meridian altitude of sun or star, as measured in the sky, for refraction. In short, whenever questions of atmospheric temperature are pushed to much refinement, the influence of watery vapour (whereon the worthy Secretary of the Society, Mr. Glaisher, has published so often and so well) is sure to come to the surface, and is found for ever mixing up with and modifying whatever goes on upon the surface of the earth.

4. The subject of storm-warnings, as inaugurated by the late lamented Admiral FitzRoy, and then their sudden abolition within the last few months either by the Board of Trade, or a Committee of the Royal Society, or by the Admiral's successors in the Meteorological Office at No. 2 Parliament Street, having excited much attention throughout Scotland, the Chamber of Commerce in Edinburgh requested the Astronomer's scientific opinion on the case; and he having thereupon sent his conclusions in the shape of a letter, the Chamber forwarded it to the Government. When the public correspondence connected with stopping the storm-signals was ordered to be printed, on 7th March, 1867, as a Blue-book, on account of a motion to that effect in the House of Commons by Colonel Sykes, M.P. for Aberdeen, the letter alluded to above was not included. But several weeks afterwards, it was published on a separate sheet of paper, and testified, albeit rather late, that though there is a wide difference, and even an impassable gulf, between the whole method of accurate observations, rigid computation, and close prediction for ages to come, as characteristic of modern astronomy, yet an astronomer could look kindly or, rather, justly upon meteorology, even in its youngest branch of storm-warnings, and could see that there were the elements there of great and important benefits to the whole community—in a manner, too, which cannot be compassed by any of the older and stricter sciences. In short, the writer earnestly recommended the national importance of meteorological storm-warnings, which united so much of Christian charity with physical science, and offered so powerful and yet so economical a means whereby an enlightened Government might daily prove its care for the interests of the people submitted to its rule, and might often save from sudden death so many lives both of sailors and fishermen that the mere cost of the official arrangements would be repaid again and again in the course of a single stormy season.

CAMBRIDGE OBSERVATORY.—The observations consisted of daily readings of the barometer, dry- and wet-bulb thermometers, maximum and minimum thermometers. Rain-gauge readings at

9ʰ A.M. The instruments were the same as in the previous year. A short weekly Report has been drawn up and sent to the 'Cambridge Chronicle' for insertion.

One of Dr. Robinson's anemometers was erected on the top of a new vane; it reads to 500 miles. The vane is supplied with a graduated circle, a fixed pointer south, vane reading 0° when south, and has been found to work very well.

I have commenced with this year to thoroughly reduce the observations made with wet- and dry-bulb thermometers from your Hygrometrical Tables.

RADCLIFFE OBSERVATORY, OXFORD.—Meteorological observations have been made at the Radcliffe Observatory, Oxford, during the past year, with the same continuous attention as in former years, and no alteration or addition worth recording has been made to the instruments. The elements observed by photographic self-registration are, as heretofore, the pressure, the temperature, and the humidity of the air, and the velocity and the direction of the wind; and the instruments have been thoroughly efficient. The process employed is that usually known as the wax-paper process, and the only difficulty experienced during the past year has been that of getting a supply of suitable paper. This process is not much used by photographers at the present time, and in consequence there is not much demand for the peculiar paper suitable for it; and the difficulty of procuring it seems to be increasing.

During the stormy weather which has been prevalent for many months (since November last, in fact) a great many interesting records of tempests have been obtained, some of which have been observed with the registers made at Kew; and the conviction seems to be becoming very strong, that self-registration in our principal meteorological observatories is indispensable.

The observations made in 1864 will be published very shortly, in conjunction with the astronomical portion of the Radcliffe observations for that year; and the results for 1865 are in process of reduction. All the astronomical calculations are very nearly complete to the present time; but, with so small a staff, it has been found impossible to push forward the meteorological reductions further than is necessary to keep pace with the printing.

The meteoric shower of November 13–14 was well observed here. A strict watch was kept during that night and the night preceding; and the number of meteors counted was about 3090.

THE NEW LIVERPOOL OBSERVATORY, BIDSTON, BIRKENHEAD (latitude 53° 24′ N., longitude 3° 4′ W.); cistern of standard barometer 212 feet above sea-level.—The new anemometer erected under the superintendence of Mr. Follett Osler, has now been in operation about three months. The external arrangements for pressure-plate, hemispherical cups, the series of fans for direction, and the rain-gauge are for the most part similar to those of the instrument which was in operation at the old observatory during the thirteen years ending December 31, 1866. The recording-arrangements are improved by the facility with which the hourly velocity is obtained, and by the addition of an endless chain which carries the direction-pencils, thereby securing a record of the direction under all possible changes. On a sheet of paper, 12 by 13¼ inches, are recorded continuously throughout the day, the pressure in pounds on the square foot, the velocity in miles, the direction of the wind, and the fall of rain. The barograph which had been in operation three years at the old observatory has been successfully removed and placed in a room by the side of the standard barometer. In addition to the rain-gauge attached to the anemometer, two others are placed 6 inches from the ground, one of which is read daily at 9 A.M., and the other at the end of every month. The standard barometer and wet and dry themometers are read daily at 9 A.M. and 3 P.M. The dry and wet registering-thermometers are read daily at 9 A.M. The records obtained from the barograph, anemometer, and pluviometer are tabulated for each hour of the day.

BIRMINGHAM AND MIDLAND INSTITUTION, BIRMINGHAM.

Horizontal motion of the Air, in miles, referred to Sixteen Points of the Compass, and Number of Hours in the several months of the year the Wind blew from each point.

1866.	N.N.E.		N.E.		E.N.E.		E.		E.S.E.	
	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.
January	154	9	......	......	......	......	......	......	4	1
February ...	346	28	20	3	24	4	58	5	57	5
March.........	475	55	343	35	154	21	178	19	183	20
April	566	60	1002	94	697	86	651	64	523	44
May	241	38	478	47	514	59	829	84	451	35
June	50	8	330	44	387	60	336	58	72	13
July	285	47	403	58	277	48	221	36	133	26
August	65	12	133	22	68	14	41	11	97	18
September ...	146	31	61	13	31	6	49	10	55	10
October	169	33	709	108	715	119	209	50	251	31
November ...	57	4	......	......	......	......	34	5	10	1
December ...	31	6	49	6	15	4	36	9	21	6
	2585	331	3528	430	2882	421	2642	351	1857	210

Horizontal motion of the Air, in miles (*continued*).

1866.	S.E.		S.S.E.		S.		S.S.W.		S.W.	
	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.
January	61	7	504	41	1409	85	2710	161	2283	167
February ...	68	8	69	8	367	39	1298	96	2061	125
March.........	470	46	472	30	338	40	612	49	515	54
April	137	18	83	12	97	12	593	52	789	50
May	179	30	161	32	129	22	315	39	532	48
June	143	18	225	35	280	35	871	88	1120	92
July	64	18	71	13	61	15	139	28	345	44
August	266	48	102	21	209	28	822	83	886	83
September ...	84	17	260	28	646	72	1335	110	1917	159
October	476	60	232	27	309	44	360	39	628	65
November ...	113	12	161	18	156	19	632	59	1735	135
December ...	135	27	63	10	237	28	732	66	2473	197
	2196	309	2403	275	4238	439	10419	870	15284	1219

1866.	W.S.W.		W.		W.N.W.		N.W.		N.N.W.	
	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.
January	2361	151	332	43	293	31	289	37	18	2
February ...	2158	149	500	42	321	36	314	52	276	41
March.........	458	49	391	39	269	24	636	101	413	52
April	1220	91	478	40	36	12	42	8	106	21
May	866	75	221	75	64	7	342	52	532	80
June	1260	108	493	60	359	41	321	38	85	17
July	1642	150	1045	90	494	45	431	44	301	58
August	1467	113	1151	104	732	70	935	88	95	17
September ...	1893	137	692	66	377	29	76	14	65	11
October	229	22	179	27	157	29	388	45	111	17
November ...	1594	136	1354	113	784	80	833	96	350	41
December ...	1987	148	1914	142	653	57	182	24	45	10
	17135	1329	9250	841	4539	461	4789	599	2397	367

Horizontal motion of the Air, in miles (*continued*).

1866.	N.		Greatest pressure during the month.	Day on which it occurred.
	Miles.	Hours.	lbs. on sq. ft.	
January	135	9	21·5	8th
February ...	249	31	18·7	23rd
March.........	570	62	21·0	23rd
April	277	49	18·5	16th
May	51	21	11·5	11th
June	15	5	12·4	17th
July	126	24	10·0	29th
August	71	12	16·5	7th
September ...	29	7	12·5	11th
October	88	28	9·5	28th
November ...	10	1	11·6	8th
December ...	17	4	14·5	9th
	1638	253		

Total horizontal motion of air during the year 1866=88,264 miles. Of this, 482 miles is not accounted for in the Table, as (owing to accidents) the *hourly* horizontal motion of the air on March 5th and 6th and on some hours of April 12th and May 27th was not recorded.

CAPE OF GOOD HOPE METEOROLOGICAL STATIONS.—In our last Annual Report we mentioned that the meteorological returns of the colonial observers were undergoing reduction with a view to their publication. These returns have since been published, and form a valuable addition to the meteorology (hitherto little known) of these districts.

These stations were founded in 1859–60, when the Colonial Parliament voted a sum of money for "establishing a system of sound meteorological observations at eligible places in the Colony;" and the selection of the instruments was entrusted to a practical meteorologist who happened to have just left the Colony for England on leave of absence. In January 1860, that gentleman arrived with the instruments in charge; and they were at once taken to the Royal Observatory, at the Cape, and the barometers mounted for comparison with the Observatory standard. The instruments consisted of ten sets supplied by Messrs. Negretti and Zambra, each set consisting of the following instruments:—

One standard barometer, with tube of the diameter 0·4 inch.
One maximum thermometer.
One minimum thermometer.
One dry- and one wet-bulb thermometer.
One blackened-bulb thermometer.
One rain-gauge (Glaisher's).

The whole of these instruments were compared with the standards of the Royal Observatory, Greenwich, by Mr. Glaisher, who furnished a certificate with each instrument.

Exclusive of the preceding instruments, six mounted barometers were purchased from Messrs. Troughton and Simms; also at a later date, from Negretti and Zambra, twenty rain-gauges (Glaisher's) and five Robinson's anemometers.

As before mentioned, the barometers were rigorously compared at the Observatories of Greenwich and the Cape of Good Hope, the result for each barometer depending upon from thirty to forty comparisons at Greenwich, and the same number at the Cape, carried on during several weeks. The two standards (Greenwich and Cape) are by the same maker (Newman), and differ only in the diameters of their tubes, that of Greenwich being 0·565 inch, and that of the Cape 0·508 inch. By means of the series of comparisons with nine out of the ten barometers sent from England (one having been broken on the passage), we obtain the following useful and interesting Table, giving with great accuracy the relation between the Greenwich and Cape standards:—

Cape Colonial Government Barometers.	Readings of—	
	Greenwich Standard —Cape Colonial Government Barometers.	Cape Standard — Colonial Government Barometers.
No.	in.	in.
290	+0·006	+0·0178
337	− ·907	+ ·0067
338	+ ·012	+ ·0249
340	+ ·016	+ ·0251
341	+ ·010	+ ·0227
342	+ ·007	+ ·0257
352	+ ·021	+ ·0287
368	+ ·025	+ ·0378
369	+ ·004	+ ·0137
Means	+ ·0104	+ ·0226

From the mean values in the preceding Table, it is evident that the readings of the Cape Observatory standard are higher than the readings of the Greenwich Observatory standard by 0·012 inch.

The verifications of the instruments having been thus performed, the several sets of instruments were distributed throughout the Colony; but, owing to the rough nature of the country, it was necessary to wait for suitable opportunities and means of conveyance in order to transport the instruments to their destinations; and there were none in position for observation before the middle of 1861.

Several changes occurred in the disposition of the instruments, which need not be herein mentioned; it will be sufficient to state that complete meteorological returns have been received and published from the following stations:—Graaff-Reinet, 1st January, 1863, to 1st January, 1866; Worcester, for the same period; Mossel

Bay, 1st January, 1862, to 27th October, 1863; Somerset West, 1st August, 1861, to 1st August, 1864; Simon's Town, 1st July, 1861, to 1st January, 1866; and Royal Observatory, Cape of Good Hope, from 1st January, 1862, to 1st January, 1866. In addition to these complete journals, there are many partial journals, consisting chiefly of records of rainfall. Observations at the foregoing stations were made at 9ʰ A.M., 1ʰ P.M., and 5ʰ P.M.; and at the Observatory additional observations were made at 5ʰ A.M. and 9ʰ P.M., at which times observations were continually made of barometer, dry- and wet-bulb thermometers, and maximum and minimum temperatures, also the estimated direction and force of the wind, the state of the sky, rainfall, and occasional remarks. These observations are reduced to mean values, the readings of the barometer being reduced to 32°, by the use of Table II. of the Report of the Committee of Physics including Meteorology, approved by the Royal Society. For the calculation of the dew-point from observations of the dry- and wet-bulb thermometers, Glaisher's Factors (Hygrometric Tables, 3rd edition, Tab. II. p. iv.) have been employed. They have been tested by Regnault's hygrometer at the Cape Observatory; and the Commission appointed to superintend the reduction of the observations has been assured that they are as suitable for the climate of the Cape as for that of England, the coincidence being as close as the direct observation of the dew-point admits of.

To diminish the trouble of interpolation, as well as the chance of committing errors when dealing with negative quantities, Tables founded on Glaisher's numbers were printed for the observers, and were employed by them for calculating the dew-point and humidity.

Finally, a few words may be devoted to the tabular results of the reduced observations; and the plan which has appeared the most compact, and which has therefore been adopted for the exhibition of the climatic circumstances of the stations, is the one employed by Sir Henry James, K.C.B., in the volume of Abstracts of Meteorological Observations at the Stations of the Royal Engineers, 1853–59. The tabular results for each month and year at each station form the chief bulk of the published returns. These are followed by a Table for each station, exhibiting the means of the more important data in the preceding pages; and these latter Tables are considered to represent approximately the climatic circumstances of the respective stations.

Then follows an important Table which provides an abstract for convenient reference and comparison. Herein we have in broad evidence the high mean temperature, the great range of temperature, the small rainfall, and the humidity of the air at Graaff-Reinet. At Worcester the annual temperature is 2° lower; yet the ranges, humidity, and rainfall are pretty nearly the same. At Graham's Town the mean temperature is also 2° lower than at Graaff-Reinet, but the diurnal range is 6° less, and the rainfall twice and half as abundant. Of the stations near the sea, there is only one year at Mossell Bay for comparison with the others —1862, a year remarkable for heavy rain; yet only 11½ inches fell there, while 36 inches fell at Simon's Town, and 32 inches at the Observatory.

With the influences that produce these differences we have not at present to deal, but with facts which more or less influence the resources of the Colony. For example, so far as the evidence contained in the last-mentioned Table extends, Graaff-Reinet, Worcester, and Mossel Bay must be content with, *and make the best of*, about one-half the amount of rain that Somerset West, Simon's Town, Cape Town, or Graham's Town is favoured with.

The Commission appointed to reduce and publish these observations concludes its able Report with the following recommendation, viz. "to provide each gaol with a rain-gauge, the gaoler to manage the register under the superintendence of the civil commissioner. Thus may be obtained, for the mere cost of the gauges, the absolute and relative falls at numerous localities throughout the Colony, and in a manner more complete than can be hoped for by any other method."

They also consider that fitting instruments for self-registering the direction and pressure of the wind are necessary adjuncts to the several instruments already provided, but cannot venture to recommend that these should be purchased, on account of their expense.

RAINFALL INVESTIGATIONS.—Mr. Symons's attention during the past year has been devoted to the examination of existing rain-gauges, rather than to the establishment of new ones. The few additional stations, however, are in very important districts, six established in Mid-Wales by Mr. Bateman, and about twenty started in Cumberland and Westmoreland by Mr. Balme of Grasmere and Mr. Symons.

The total number of gauges visited and tested is now considerably over 200, and almost weekly increasing. The experimental gauges started by Colonel Ward, Rev. J. Chadwick Bates, Mr. Chrimes and Mr. Symons are all continued, and some of the results are under discussion; the last-mentioned set have been removed to a more open position and placed under the care of Rev. T. E. Crallan, Framfield Lodge, Uckfield.

The amount of evaporation from rain-gauges cursorily referred to last year has so recently been discussed in our 'Proceedings' (vol. iii. p. 326 and 408) that further notice is unnecessary.

The last subject requiring mention is the plan proposed and carried out by Mr. Symons for obtaining the altitude of stations at a distance from the lines of levelling of the Ordnance Survey, by discussing a set of simultaneous barometer readings taken during the ten days May 24th to June 2nd, 1867, inclusive. Of course these will only yield approximate results; but they will remove much uncertainty (being probably correct to 20 ft.), and in their turn they will give place to accurate results when the spirit-levelling has been carried up to the various places. At present many gauges are twenty miles or more from the nearest Ordnance bench-mark.

The Meteorological Society of Mauritius.—The Society and the Observatory have been working together under a Committee, the Government of the Colony voting an annual grant for meteorological purposes, and the Members of the Society contributing towards the repayment of the expense by their annual subscriptions. One main object has been to establish subsidiary observatories at outposts; and observations are now being taken systematically at Rodriguez, Seychelles, and the capital of Madagascar, by competent observers with standard instruments. We hope to be able to extend our operations to some other stations in the Indian Ocean, as Agalega and St. Brandon. In Mauritius itself there are, besides the Observatory, four stations at which observations on the pressure and temperature of the air, &c., are taken at stated hours daily, and twenty-one stations at which the rainfall is registered. There are other stations, at which the temperature alone is recorded. All these observations are forwarded monthly to the central Observatory for reduction &c. Hitherto the Observatory staff has not been numerous enough to take more than five daily and hourly observations on the 21st of each month; in bad weather, however, half-hourly observations are frequently taken. A new Observatory is about to be built in a better locality; and the object of my visit to England is to make the necessary arrangements for procuring working-plans for the buildings, instruments, &c. Lately a time-ball service has been established; and the new Observatory will have also to occupy itself with terrestrial magnetism as well as meteorology. The instruments, both magnetical and meteorological, are to be self-recording. In an island like Mauritius, depending on agriculture and commerce, the study of changes of weather naturally engrosses considerable attention. During the hurricane-season, in particular, the state of the barometer and weather is anxiously watched by all classes, but more especially by the planters; and so unerring are the signs of an approaching hurricane, and so well are they known even by the common people, that a storm never visits the island by surprise. Another great object of the Society has been to trace the rise and progress of gales and hurricanes in the Indian Ocean, and, indeed, of all marked changes of weather. For this purpose the meteorological data obtained from ships' logs are carefully tabulated in chronological order. This work has been carried on during the last fourteen years, and a large body of facts is now collected. About 170,000 *days'* observations in the Indian Ocean are now available for the construction either of "synoptic" or "mean" charts of the force and direction of the winds, &c. Many of the hurricanes that have occurred in the course of that period have been described in the Society's Transactions. A considerable number of synoptic charts showing the winds and weather at noon have also been projected; and the Society is taking steps for publishing a chart for each day for a period of twelve months. There is a wonderful and a beautiful connexion between the gales and hurricanes at a distance and the weather at Port Louis. By watching the barometer, the wind, and the sky, the existence of a gale, and its locality, may be known with certainty.

The Council cannot help expressing regret that a Committee of the Royal Society has discontinued the use of storm-warnings, particularly on occasions of well-marked storms, whose courses are known in time to warn the ports and places which they are likely to pass.

The Council also are unable to see how the mere establishment of six observatories, where observations have already been made for many years, can much advance our knowledge of meteorology.

The following is a Tabular statement of the present strength of the Society:—

	Fellows.			Totals.
	Life.	Ordinary.	Honorary.	
1866, June 20	56	262	10	328
Since elected	...	24	...	24
Since compounded ...	+1	− 1	...	0
Deceased	...	− 4	...	− 4
Retired	...	−17	...	−17
1867, June 19	57	264	10	331

The Society has to regret the death of several of its Fellows; the deceased Fellows are:—

Thomas Herbert Barker, Esq., M.D., F.R.C.S., F.R.S.E., who was elected into the Society on May 7, 1850.

Alexander John Cuming, Esq., A.K.C., elected June 17, 1863.

George Dollond, Esq., F.R.A.S., elected November 27, 1855.

J. Lake, Esq., C.E., elected March 19, 1862.

THOMAS HERBERT BARKER, M.D., F.R.C.S., F.R.S.E.—At the age of fourteen, Thomas Herbert Barker was apprenticed to Mr. Harris, a surgeon practising in Birmingham, with whom he stayed four years. He afterwards pursued his studies in Birmingham for one year, taking out his lectures at the Snow Hill School of Medicine, and his practice at the General Hospital. At the age of twenty years he went to University College, London, and for twelve months was house surgeon to the University College Hospital. During the period of his London life he stayed for some months with Dr. Copland, and wrote out from the learned doctor's notes, or from dictation, many a page of the now famous and world-spread Dictionary. He has told us, more than once, that these lessons in literature gave him his taste and relish for the prosecution of scientific medicine; they opened to him how much there was to be done, how much had been accumulated, and how little was known.

Dr. Barker qualified for the practice of his profession in the year 1837, by passing at the Apothecaries' Hall. In 1842 he passed the College of Surgeons as a member; in 1845 he passed for the M.B. of the University of London, and in 1847 for the M.D. of the same University; in 1851 he took up the F.R.C.S. by examination. So far as degrees were concerned, he thus obtained all that were in the reach of the man who is in general practice, the most difficult and the highest.

Soon after becoming qualified he settled in Bedford. And there might be surgeons who on particular points of operations were superior, and physicians who in special points of practice were superior; but, accepting him as physician and as surgeon, he combined the arts in a degree truly surprising. His medical knowledge in diagnosis was of the positive kind, and his views on treatment clear, common-sense, advanced. His surgical knowledge was equally sound; and when the surgeon's knife was in his hand, he was as collected and as calm, if not as brilliant, as his master, Liston.

His writings had and have about them a practical value. The subjects are obviously spontaneous, and the style also. The style is never obscured by hard terms, never scientific for the mere sake of being so, and never so popular as to be out of the pale of strict science.

Omitting his minor essays, his numerous published letters, and his reports of private cases, we may refer to his paper on 'Entozoa,' his essay on 'Malaria,' and his last essay on 'Disinfection and Deodorization,' published in the 'British Medical Journal,' on the first day of the present year (1866), as his masterpieces. These essays all obtained prizes: the first had awarded to it the silver medal of the Medical Society of London; the second the Fothergillian gold medal of the Medical Society of London; and the last the Hastings gold medal of the British Medical Association. The grand characteristics of each of these works is *industry*. They are clear expositions of all and everything upon which they treat; they exhibit learning, judgment, and knowledge—but far above all, industry. If this industry, so pointed, so forcible, had been tipped never so faintly with genius, the works would have ranked amongst the first of the age.

Apart from the direct position of the practioner, Dr. Barker stood prominent as a practical sanitarian. His first labours in sanitary service had reference to his own locality. His reports on the mortality of Bedford and of thirty-nine rural parishes; and his papers 'On Foul Air and Fever as exemplified in the sanitary condition of Bedford,' were essays as clear and precise as they were outspoken and honest. They had one misfortune only, that of being lessons in advance of their time; and they called down, as all such useful and novel labours must, severe local criticism, which was to him (for he was excessively susceptible under unfair criticism) a source of much anxiety and pain. They raised his impulses perhaps unduly at times; but withal he was in every sense to be excused, for, labouring for the common good, he was assailed as fiercely as though he were bringing down on his townsmen a common calamity. In the end his arguments prevailed of course, and at this time Bedford is a healthier town than it was before he commenced his unsparing and vigorous work; but it would have been one of the most healthy of towns by this time, had his views and teachings been received with proper attention and studied with an unbiased determination to learn from them the important truths they conveyed.

As a sanitarian Dr. Barker saw also the importance of combining social with sanitary improvements; and one of his suggestions in this direction is singularly happy. He proposed, towards the close of the year 1864, the erection of town and village kitchens, where the food of the poor might be cooked at little expense and in a way that should render it most wholesome and most nutritive. To be able to carry out this plan, he calculated with extreme care every possible source of expense, and he had it in his mind to put the principle practically to the test. His paper on this subject will be found in the 'Social Science Review' for December 1864.

In the study of physical science there was never a more ardent student: every new discovery was to him a source of joy and pride. He was a fair chemist, an astronomer of some practical skill, and a good, diligent, and practical microscopist. He had a taste for meteorology from his earliest days, and he retained and quickened it to the last. He transformed his garden into an observatory, planted it with good instruments, and took his observations with punctuality. At his instance, a registration of disease in relation to meteorological phenomena was commenced many years ago in the 'British Medical Journal,' was continued for a considerable period, and ought never to have been abandoned. For services rendered to meteorological science, and for successfully defending their privileges when the published records they furnished to the Government were denied them, a large body of meteorologists presented Dr. Barker with a testimonial in the form of a chronometer, in 1858.

The study of antiquities and of history was pursued by Dr. Barker rather as an amusement than as a labour. In these departments he had no ambition to excel; but when he touched he could not help seizing; and many a dry-as-dust, who knew no more than our busy friend, has become celebrated simply because on other matters he knew nothing at all.

Finally, it was the object of Dr. Barker's life to become the medical biographer of his day and generation. He wished, he told us, "to throw into the future a faithful representation of medicine as he saw it." This was the origin, this the intention, of those biographical memoirs; and whoever may have read them with care must feel that they offered, as they came from their master's hand, evidence of singular talent and aptitude for the special work. The analyses have been so just, the estimates so fair, the award of honour so delicate, that even those who have been most opposed to the system of contemporary biography, have been unable to expose even a fault in the details.

In addition to his medical qualifications, Dr. Barker was a Fellow of the Royal Society of Edinburgh, ex-president of the South Midland Branch of the British Medical Association, president of the Bedford Literary Institute, corresponding member of the Natural History Society of Neuchâtel, a Fellow of the Medical Society, the Royal Medico-Chururgical, the Obstetrical, the Epidemiological, the Pathological, and the Microscopical Societies of London, and a Fellow of the British Meteorological Society. He was one of the most active members of the British Medical Association.

In the death of Dr. Barker the general practitioners of medicine in England have lost one of their representative men—perhaps, as a man of general science as well as a practitioner of medicine, *the* representative man of their body. In his death science altogether has sustained a loss it is hard to estimate; for he was still young in thought and action, and old only in experience and knowledge. But through our sorrow there shines forth the hope that his example will not be lost. Dead he is in his mortality; but his spirit still lives with us, teaching to the humblest working student, to the proudest scholar, the lessons, that labour hallows small and great, and that nothing is hallowed that is not laboured. Let our tears dry. *Mori est felicis antequam mortem invocet. Vale.*

Mr. A. J. CUMING was born at Portsmouth on the 13th of May, 1843. He was the eldest son of George Cuming, Esq.—a direct lineal descendant of the Cuming, so famous in Scottish history, who was killed by Robert Bruce in the church of Dumfries.

He early showed a decided taste for engineering and mechanical pursuits, and when only fourteen constructed a working model of a steam-engine, with the aid of an amateur's lathe, without having had the advantage of examining the parts of a steam-engine before; and in the same way he made a small hydraulic ram. Indeed he had little love for the sights which usually interest children, but was at once attracted by anything in the shape of mechanism.

At the age of sixteen he entered King's College, London, where he remained three years. At the end of his first year he came out Divinity and Mathematical prizeman, and in each of the two succeeding years carried off the prize for mathematics.

The early bent of his mind for the profession of civil engineering never wavered, but became more fixed and decided as the time drew near for him to make choice of a profession; and in February 1863 he was articled to Mr. Beardmore, Member of the Council of the Institution of Civil Engineers, and late President of this Society, with whom, when the three years of his articles expired, he remained as an assistant, and by whom he was much valued and esteemed.

Mr. Cuming was enthusiastically fond of his profession, following it with an earnestness and self-reliance which gave promise of future usefulness and success. Of his great talent, untiring energy, perseverance, and inventive faculty there could be but one opinion.

On June 17, 1863, he was elected a Member of this Society. At the Anniversary Meeting in 1865 he was appointed Librarian, a post he very ably filled; and in June 1866 he was elected Member of Council. He contributed several papers to the 'Proceedings' of the Society, and carried out some experimental inquiries on the fall of rain.

On the 8th of October, 1866, he was seized with rheumatic pain in the knee, which soon developed itself as rheumatic fever, from which, however, he was rapidly recovering, when early on the morning of the 23rd he died quite suddenly from fatty degeneration of the heart, which disease, quite unknown to himself or friends, had been more than two years sowing the seeds of his lamented death.

George Dollond.—Born 18th of December, 1797, died 22nd of September, 1866, educated at Dr. Lord's School at Tooting; succeeded his uncle in St. Paul's Church Yard, 1852. He was a F.R.A.S., F.R.G.S., and a Member of the Corporation of the City of London, &c. &c.

The following Papers have been read at the Ordinary Meetings during the Session 1866–67:—

1. "Comparison of Standard Barometers at different Observatories in Europe." By Lieut. Rikatcheff, I.R.N.
2. "Comparison of Thermometers at different Observatories in Europe." By Lieut. Rikatcheff, I.R.N.
3. "On the Percentage of Rainy Weather." By R. Strachan, Esq., F.M.S.
4. "On an Improved Anemometer." By L. P. Casella, Esq., F.R.A.S.
5. "Meteoric Shower of November 13–14, 1866."
6. "Terrestrial Magnetism." By J. C. Bloxam, Esq., F.M.S.
7. "On the Evaporation of Rain from Rain-gauges." By G. Harvey Simmonds, Esq., F.M.S.
8. "On the Difference of Temperature of Two Strata of Air at Unequal Heights." A communication by Prof. D. Ragona-Scina, Director of the Royal Observatory at Modena, to the Austrian Meteorological Society. Translated, with Addenda, by J. Staughton Harding, Esq., F.M.S.
9. "On the Anemometers at the Royal Observatory, Greenwich." By John Browning, Esq., F.R.A.S.
10. "Notices of Luminous Meteors seen in the month of August, extracted from the Meteorological Register kept on board the barque 'James Longton.'" By Capt. H. S. Millard.
11. The Evaporation-Gauge (Atmometer) in its simplest form." By Dr. M. A. F. Prestel. Translated from the 'Zeitschrift der österreichischen Gesellschaft für Meteorologie,' vol. i. No. 13, by G. Harvey Simmonds, Esq., F.M.S.
12. "Atmospheric Pressure in Natal, South Africa." By R. J. Mann, Esq., M.D., F.R.A.S., F.M.S., &c.

13. "On the Earth-current and Telegraphic Currents." By Professor Lamont. Translated by W. T. Lynn, Esq., B.A., F.R.A.S., of the Royal Observatory. Greenwich.
14. The Influence of the Moon on the Direction of the Wind." By James Glaisher, Esq., F.R.S., Secretary.
15. "On the Phenomena of Meteors." By E. T. Loseby, Esq.
16. "On the November Shower of Meteors." By Herr Pihl, Christiania.
17. "On the recently conjectured Identity of April Meteors with Comet I. 1861." By W. T. Lynn, Esq., B.A., F.R.A.S.
18. "Meteorological Notes on Jersey." By Lieut.-Colonel Austen, F.M.S.
19. "On the Storm of Monte Video, 27th of October, 1866." By Albert De Lisle, Esq.
20. "On the Temperature at Different Heights." By J. C. Bloxam, Esq., F.M.S.
21. "On a Hailstorm at Leamington, upon Sunday, April 14th, 1867." By S. Urwick Jones, Esq., F.M.S.
22. "On Determination of Heights from Barometer Readings." By the Astronomer Royal.
23. "On the Diurnal Variation of Terrestrial Magnetism." By John Bloxam, Esq., F.M.S.
24. "The Anemometric Records of the Greenwich and Kew Observatories Epitomized and Collected." By Colonel Austen, F.M.S.
25. "Ideas on the right Mode of Observing and Interpreting Barometric Fluctuations." By Joseph John Murphy, Esq.

Resolved:—

That the Report, which has just been read be received and adopted, and that it be printed and circulated among the Fellows of the Society.

Proposed by Dr. Hering.
Seconded by Dr. Mann.

That the cordial and best thanks of the Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

Proposed by the President.
Seconded by Mr. Walker.

That the best thanks of the Society be given to Dr. Tripe for his services as Secretary, with regret that his engagements prevent him being able to retain the office longer.

Proposed by Mr. Gaster.
Seconded by Mr. Strachan.

The President appointed Dr. Mann and Mr. Browning as Scrutineers; a ballot was then taken, and the following list of Members, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the nineteenth Session, 1867–68 :—

THE OFFICERS AND COUNCIL

OF

THE METEOROLOGICAL SOCIETY,

ELECTED 19TH OF JUNE, 1867.

President.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., &c.

Vice-Presidents.

A. BREWIN, Esq.
W. P. DYMOND, ESQ.
H. S. EATON, Esq., M.A.
C. V. WALKER, ESQ., F.R.S., F.R.A.S.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square*, W.

Trustees.

ANTONIO BRADY, ESQ., F.G.S. &c.
S. W. SILVER, ESQ.

Secretaries.

C. BROOKE, ESQ., M.A., F.R.S. &c., 16 *Fitzroy Square*, W.
C. O. F. CATOR, ESQ., M.A., *Beckenham*, S.E.

Foreign Secretary.

LIEUT.-COL. ALEX. STRANGE, F.R.S., F.R.A.S., 41 *Brompton Crescent*, S.W.

Council.

N. BEARDMORE, Esq., C.E., F.R.A.S., F.G.S.
E. W. BRAYLEY, Esq., F.R.S., F.G.S., &c.
WILLIAM BROOKE, Esq., F.R.A.S.
GEORGE DINES, Esq.
F. W. DOGGETT, Esq.
ISAAC FLETCHER, Esq., F.R.S., F.R.A.S., &c.
W. HERING, Esq., M.D.
Rev. J. B. READE, M.A., F.R.S., F.R.A.S.
G. H. SIMMONDS, Esq.
T. SOPWITH, Esq., M.A., F.R.S., F.G.S., &c.
G. J. SYMONS, Esq.
S. C. WHITBREAD, Esq., F.R.S., F.R.A.S.

The Treasurer's Account for the year 1866.

Receipts.

		£ s. d.	£ s. d.	£ s. d.
1866.				
Jan. 1.	To Balance of last year		50 16 10	
	Do. of Charter Fund		38 8 6	89 5 4
April.	Dividend on £800 New 3 per Cents.		11 16 0	
Oct.	Do. do. do.		11 16 0	
	DIVIDENDS		23 12 0	
Dec. 31.	Subscriptions for 1865	13 0 0		
	Do. for 1866	195 5 0		
	Do. for 1867	4 0 0		
		212 5 0		
	Composition of:—			
Jan. 2.	Lt. Verney, R.N.	30 0 0		
April 3.	T. H. Morgan, Esq.			
Dec. 15.	S. Barker, Esq., M.D.			
	SUBSCRIPTIONS		242 5 0	
Dec. 31.	Sales of Proceedings, &c.		9 7 10	
Dec. 31.	Total RECEIPTS			275 4 10
				£364 10 2
1867.				
Jan. 1.	To Balance			£2 18 0

HENRY PERIGAL, JUN., *Treasurer.*

JOHN BROWNING, } *Auditors.*
W. C. NASH, }

The Treasurer's Account for the year 1866.

Expenditure.

1866.			£ s. d.	£. s. d.
Jan. 17.	By Proceedings, No. 22		17 11 0	
Feb. 21.	Do. No. 23		22 2 6	
Mar. 21.	Do. No. 24		21 1 6	
Apr. 18.	Do. No. 25		16 15 9	
June 20.	Do. No. 26		41 9 5	
Nov. 21.	Do. No. 27		47 3 6	
	PROCEEDINGS, Six Nos.		166 3 8	
		£ s. d.		
June 30.	Registrar-General's Reports	3 3 0		
Dec. 31.	Do. do,	2 16 0	5 19 0	
	PRINTING			172 2 8
Dec. 31.	Stationery		10 19 1	
	Post Stamps		15 17 7	
	Secretary and Editor's Petty Expenses		3 5 6	
	Attendance and Refreshments		8 17 10	
	EXPENSES			39 0 0
	Assistant to Editor of Proceedings		52 0 0	
	Collector's Commission		10 12 0	
	SALARIES			62 12 0
Dec. 31.	Total PAYMENTS			£273 14 8
Nov. 20.	£100 New 3 per Cents (Investment of Compositions)			87 17 6
Dec. 31.	BALANCE			2 18 0
				£364 10 2

1867.
Jan. 1. *Funded Property now £900 New 3 per Cents, representing annual Income of £27.*

The following Resolution was then put to the Meeting and carried unanimously:—

> That the thanks of the Society be given to the Officers for their services during the Session that has now closed.
>
> Proposed by Mr. Dines.
> Seconded by Mr. Tabor.

NOTICE.

SESSION 1867-68.

The Meetings will be held on the Third Wednesday in the months, at 25 GREAT GEORGE STREET, WESTMINSTER, S.W., by the kind permission of THE COUNCIL OF THE INSTITUTION OF CIVIL ENGINEERS.

ORDINARY MEETINGS at 7 P.M.

1867.	November	20	1868.	March	18
1868.	January	15	„	April	15
„	February	19	„	June	17

The Annual General Meeting will be held after the Ordinary Meeting on June 17.

COUNCIL MEETINGS at 6 P.M.

1867.	October	16	1868.	March	18
„	November	20	„	April	15
1868.	January	15	„	June	17
„	February	19			

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